Six Decades of Horticulture Development in Nepal

(Silver Jubilee Special)

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MESSAGE FROM THE PRESIDENT

Nepal is an agriculture dominated country where more than 75 per cent people live in rural areas, about 60 per cent of total population depends on agriculture for their livelihood and share in GDP is also more than 33 per cent. In agriculture, horticulture sector has great role in the growth and development and present share in AGDP reach up to 21 per cent including the share of potato. Among the exportable agricultural commodities horticultural commodities like large cardamom, ginger, tea and coffee have significant contribution to the total export value. In the last six decades, there has been remarkable progress in policy development, institutional development, technology generation and transfer. Developmental institutions both public and private sectors have come up with their activities on promoting horticultural business on various sub-sectors such as fruits, vegetables, flowers, plantation crops, spices and medicinal herbs. Technical books related to cultivation practices on above subjects have been published by many institutions and on personal basis but developmental and prospects related books are lacking in the market. To fulfill this gap Nepal Horticulture Society (NHS) has decided to publish a book entitled "Six Decades of Horticulture Development in Nepal" on the auspicious occasion of Silver Jubilee year, 2015. Many formal and informal meetings were held in NHS secretariat to finalize the title, contents and review work.

In this regard, I would like to express my sincere appreciation and thanks to advisory committee, executive committee, international horticulture conference organizing committee and all other members who have attended the meetings and provided valuable comments/ suggestions. Special thanks are offered to Mr. Bhairab Raj Kaini, past president of NHS and former joint secretary of MoAD for selecting relevant topics and identifying authors. I am indebted to all authors who have put hard labor voluntarily to prepare articles in short period of time. I want to extend my feelings of gratitude to Prof. Dr. Gyan K Shrestha, immediate past president of NHS and Chair of Publication Committee and other members of publication committee for their commendable editorial works. Last but not least, I offer cordial thanks to Mr. Bashu D

Subedi, General Secretary, Mrs. Yam Kumari Shrestha, Treasurer and all other executive committee members for their help and cooperation from beginning to the end.

Lastly, I hope this book will be useful to horticulture researchers, planners, development workers, students and many others who are involved in research and developmental works.

Mohan Bahadur Thapa
April, 2016

CONTENTS

HORTICULTURE IN NEPAL: JOURNEY IN THE LAST SIX DECADES

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ABSTRACT

Horticulture was limited to growing indigenous fruits and vegetables during 50s and earlierin the private sector, while collecting and growing fancy plants existed in the palaces of Rana Prime Ministers . Horticulture development at the government level started during fifties when the Horticulture Division was created in the newly established Department of Agriculture. Many farms were established during sixties, commodity development divisions were established in seventies, several projects were implemented and NARC was established in eighties, concept of privatization and sustainability of horticultural farms was introduced in nineties, and commodity divisions were promoted to directorates and horticultural farms were given commodity specific mandates and their names were also changed accordingly. In the last sixty years, there has been significant progress in policy development, institutional development, and technology generation and transfer. Fruit production has increased to 965,000 mt, vegetable production to 3,421,035mt, and potato to 2,817,512 mt from almost less than 100,000 mt during the early fifties. With Nepal's membership to WTO and regional trade associations, increasing education levels and nutrition knowledge of the people, increasing demand for fruits and high import, etc. shows high prospects for horticulture development in Nepal. Promotion of horticultural business, promotion of foreign investment, and enhancing production are some of the ways ahead in horticulture development. In order to harness the potentiality of horticultural development in Nepal experience shows that there are challenges such as enhancing production, improving physical infrastructure, enhancing marketing, and promotion of processing, to be addressed.This paper has tried to give a short glimpse of horticulture development in the last sixty years in Nepal. It has focused more on the institutional development history, major successes, prospects and challenges for development.

INTRODUCTION

Nepal is shaped roughly in trapezoidal manner , 800 km (497 mi) long and 200 km (124 mi) wide, with an area of 147,181 km2 (56,827 sq mi). It lies between latitudes 26° and 31°N, and longitudes 80° and 89°E.

Physiographic situation of Nepal has given rise to diverse climatic condition and that gave large biodiversity. One could find wild plants of Mandarin in Magtewa in the east and many Mandarin cultivation in surrounding districts Khokho, Chintang to name, so also Custurd Apple in Dhankuta; similarly wild Amala plants in the Jasbhire slope way to Indravati river to Chautara; wild Citron and Olive plants in the West.

Prior to Rana Regime (prior to 1950) horticulture grew as a collection of fancy and exotic horticultural plants such as persimmon, loquat, some peaches, pears, figs, litches and mango; and flowering plants like coral, magnolia, Chiniya rose, and evergreen plants like exotic pines, monkey puzzle nut, etc. in Putali Bagaincha (literary in English translation is Butterfly Garden) which was meant for entertaining Rana Prime Ministers. There was a Plant Introduction Unit established in Godawari to maintain the introduced plants in situ.In the private sector, horticulture during that period was limited to growing indigenous fruits such as traditional guava, pear, citrus, etc. and some vegetables such as mustard leaf, pyate – red turnip, different types ofradish, beans, cucurbits, etc. Generally, fruit growing was limited to homestead gardens with few trees scattered here and there.

Horticulture development at the government level started during fifties when the Horticulture Division was created in the newly established Department of Agriculture. Horticulture farms were established at Kakani, Pokhara.

During sixties, Department of Horticulture was established. There were 13 horticulture farms established at Kirtipur, Pokhara, Dhankuta, Dhunibeshi, Kakani, Palpa, Janakpur, Helambhu, Baitadi, Jumla, Marpha, Sarlahi, Rampur and Humla with the support from Indian Cooperation Mission (ICM). GTZ supported Gandaki Zone Agriculture Development Project GADP was started in 1969 that had a significant component on horticulture development. Similarly Japan helped to establish Janakpur Zone Agriculture Development Project (JADP) and has impact in the development of Junar in Sindhuli and Ramechap. Karnali Bheri Integrated Rural Development Project K-BIRD has impact in the west.A fruit preservation unit was established at Kirtipur. Production and distribution of fruit saplings and some vegetable seeds started from various farms. Many private nurseries andcommercial orchards were established.

During seventies, government gave further impetus to horticulture development. Fruit Development Division (FDD), Vegetable Development Division (VDD), Potato Development Division (PDD) and National Citrus Development Programmes (NCDP) were started. Nepal implemented Ten Years Agriculture Plan 1975-85 (2030-40 BS). During this period, horticulture component was introduced in various agriculture stations such as Parwanipur, Bairawa, Nepalgunj and Tarahara Bitarnagar. Horticulture farm Panchkhal was established in 1975. Agriculture farm in Solu and Dailekh were established in 1975 and 1977 respectively. FAO supported Hill Agriculture Development Project (HADP) was started in 1973 which strengthened Horticulture Farms of Kirtipur, Trisuli, Jiri, and Jumla. It also imported and distributed germplasm of many kinds of fruits. JICA supported Janakpur Agriculture Development Project was started in 1973. Commercial orchards were developed at the private sector. Vegetable Seed Production Centre Mushikot was established in 1978. Horticulture Farms/Stations carried out fruit research and developmentactivities under technical guidance of FDD, NCDP, vegetable research activities under the guidance of VDD and potato research activities under the guidance of PDD.

During eighties, a separate post of DDG Horticulture was created in the Department of Agriculture in 1982. Citrus Development was given a national priority. FAO/UNICEF supported Vegetable seed production project was started in 1982. Vegetable Seed Production Centre Dadeldhura was established in 1982. JICA supported Horticulture Development Project (HDP) was started in 1985 and ADB supported Hill Fruit Development Project was started in 1987. Kalimati Fruits and Vegetable Wholesale Market was established in 1986. Agricultural research was given a special focus and a separate research wing named Nepal Agricultural Research and Services Centre was created in 1987 which was promoted to Nepal Agricultural Research Council in 1991.

During nineties, Department of Horticulture was re-established . Some horticulture farms such as Horticulture Farm Rasuwa and Helambu

(Orchard site) were handed over to the Ministry of Forests and Soil Conservation and Horticulture Farm Kakani to the Ministry of Tourism. Some farms namely Horticulture Farms Humla, Dhunibesi, Helambu (Sermathang) and Janakpur were privatised with certain criteria to ensure the continuation of horticultural activities in the farms. In 1979, five agriculture related departments were merged to create the Department of Agriculture Development (DOAD). In 1993, a post of Assistant Horticulturist was created in each District Agriculture Development Office. In 1994, Horticulture Farms Humla, Dhunibesi and Helambu (Sermathang) were re-turned back to the Government by the private sector. In 1980, Department of Livestock Services was separated from the DOAD and the DOAD was renamed to Department of Agriculture. Tea and Coffee development board was established in 1993. In 1995, 20-years' Agricultural Perspective Plan (APP) was formulated and implemented. Of the four priority outputs, high value commodity was one, including horticulture. In this decade, Nepal Horticultural Society was also established (1990). Floriculture Association Nepal (FAN), a private sector initiative was started in 1992.

After the millennium, Ministry of Agriculture and Cooperatives was restructured in 2002. The commodity development divisions were renamed to development directorates such as Fruit Development Directorate (FDD) and Vegetable Development Directorate (VDD). National Citrus Development Programme, and Tea and Coffee Development Programmes were kept under FDD. Potato Development Programme and Spices Development Programmes were kept under VDD. Different horticultural farms were renamed according to the functions they were carrying out, such as Horticultural Farm Sarlahi was renamed to Tropical Fruit Farm, Horticultural Farm Panchkhal was renamed to Spice Development Farm.

MAJOR SUCCESSES

Policy Development

There has been several policies being developed and implemented to promote horticulture development in the country. The major policies include: Ten Years Agriculture Plan (1975-85), Agriculture Perspective

Plan (1995-2015), Seed Policy (1999), National Tea Policy 2000, Fertilizer Policy (2002), National Coffee Policy 2003, Irrigation Policy 2003, National Agriculture Policy (2004), Agribusiness Policy (2007), Agrobiodiversity Policy (2006), Land Use Policy (2012), Irrigation Policy (2013), National Seed Vision (2013-2025), Agriculture Mechanization Policy (2014), Agriculture Development Strategy (2015) the latest.

Institutional Development

There has been significant development in training, research and extension institutions. Tribhuvan University, Agriculture and Forestry University, Pokhara University and Purvanchal University offering higher level degree in agriculture. There are schools giving technical education. There are training centres giving vocational education on agriculture.

There are eight commodity associations: Nepal Ginger Producer and Traders Association, Nepal Tea Planters Association, Nepal Tea Association, Himalayan Orthodox Tea Producers Association-Nepal, Seed Entrepreneurs Association of Nepal (SEAN), Floriculture Association Nepal, Coffee Producers' Association Nepal, Federation of Fruits and Vegetable Entrepreneurs, Nepal (FEFVEN), Nepal Mushroom Association,

There are more than 500 commodity specific cooperatives (Vegetable and Fruit – 202, Tea – 109, Coffee – 146, Junar – 44), and their Federations. Likewise, there are 8,069 Agriculture Cooperatives which also deal with horticultural commodities. At the grassroots level, there are more than 25,000 producers' groups organised in various commodity groups including fruits, tea, coffee, vegetables, spices and vegetable seeds.

Technological Generation and Transfer

From traditional methods of growing and indigenous varieties, Nepal has progressed significantly in developing horticultural technologies. Vermicomposting technology is gradually replacing chemical fertiliser in horticulture and is contributing to improve soil fertility and food quality. Biotechnology such as tissue culture is contributing to produce disease free saplings, TPS technology in potato is contributing in virus filtration, IPM and IPNMS technologies are contributing in reducing the use of chemical pesticides and fertilizers, water harvesting and multiple use water system, and drip and sprinkler irrigation technology are contributing in efficient utilisation of water, riverbank farming has increased the scope of vegetable farming for landless and marginal farmers.

There has been significant improvement in varietal development. As compared to a traditional cauliflower variety grown in Kathmandu Valley by Jyapu farmers, there are 43 varieties of cauliflower in Nepal. Likewise, there are 33 varieties of cucumber, 28 varieties of cabbage, some are day neutral, 27 varieties of tomato, 17 varieties of radish, 17 varieties of bitter gourd, 8 varieties of potato, 6 varieties of broad leaf mustard, etc (VDD, 2014).

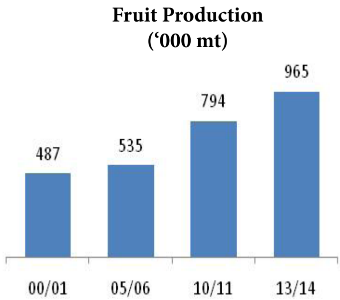
Remittance income and knowledge of returnees

Off season vegetable production was specified in 20 Years Agriculture Plan APP.There have been several off-season production technologies brought by the returnees working abroad. These social remittances (knowledge of new technologies and skills) have contributed in the supply of off-season vegetables, especially tomatoes, cucumber, bitter-gourds, and exotic fruits such as kiwi, avocado and strawberry.

Production and Productivity Enhancement

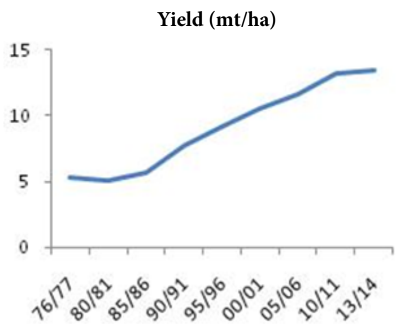
Production and productivity of horticultural crops have increased significantly in the last six decades. Available data shows that production has doubled in the last 25 years, vegetable production has increased almost by eight folds in the last 40 years, and potato by more than 10 folds (Tables 1-3). Though area and production of fruits have increased, fruit yield is hovering around 10 mt/ha. There is still a lot to be done to increase fruit productivity. Supply of quality planting material, proper orchard management including manuring, irrigation, training and plant protection have been found as major areas for intervention. In case of vegetables and potato, production and yield have increased over time. Despite the potential of horticulture, horticultural productivity remains low due mainly to the lack of access to information, technology, inputs (seeds, fertilizers, credit) and market.

Table 1: Area and production of fruits				
Year	Total area ('000 ha)	Productive area ('000 mt)	Production ('000 mt)	Yield (mt/ha)
1985/86	NA	NA	364	NA
1990/91	NA	NA	502.36	NA
1995/96	NA	NA	367.49	NA
2000/01	73.775	48.166	487.326	10.12
2005/06	91.923	56.549	535.449	9.47
2010/11	117.932	79.184	794.164	10.03
2013/14	148.208	110.086	965.044	8.77
Source: MOF, 1998; MOAD, 2014				

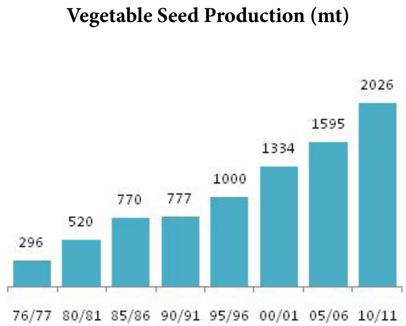


Vegetable production has increased significantly. Data shows that only 13 percent of the vegetables transacted in Kalimati Wholesale Market was imported in 2007 (Awasthi, 2007) while some 15 years ago the scenario was reverse. Local production was meeting only 13 percent and 87 percent of the transacted vegetables used to be imported.

Table 2: Area and production of vegetables			
Year	Area ('000 ha)	Production '000 mt)	Yield (mt/ha)
1976/77	85.00	442.00	5.20
1980/81	104.00	521.34	5.01
1985/86	138.59	782.53	5.65
1990/91	140.50	1074.65	7.65
1995/96	144.37	1327.29	9.19
2000/01	157.162	1652.979	10.52
2005/06	189.832	2190.1	11.54
2010/11	244.102	3203.563	13.12
2013/14	254.932	3421.035	13.42
Source: MOF, 1998; MOAD, 2014			



Vegetable seed production has increased significantly. It has increased almost by seven folds. Nevertheless, the area under improved seed is estimated to be still less than 50 percent. The current level of vegetable yield is 13.42 mt/ha while the potential yield with the current level of technological development is 17 mt/ha. Though seed alone increases yield by 30 percent, the seed replacement rate in vegetables has been only 67 percent.



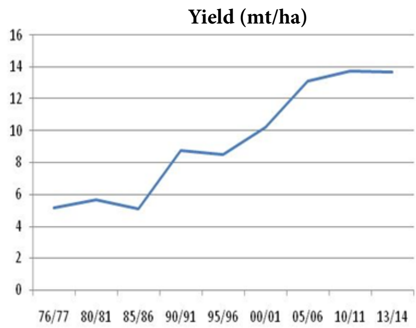


Table 3: Area and production of potato

Year	Area ('000 ha)	Production '000 mt)	Yield (mt/ha)
1975/76	52.29	270.25	5.17
1980/81	49.58	280.54	5.66
1985/86	69.96	356.72	5.10
1990/91	84.28	738.03	8.76
1995/96	106.00	898.35	8.48
2000/01	129.02	1313.72	10.18
2005/06	150.86	1974.76	13.09
2010/11	182.60	2508.04	13.74
2013/14	205.73	2817.51	13.70
Source: MOF, 1998; MOAD, 2014			

Contribution to total agricultural production

Segregated data on contribution of horticulture to total agricultural production is available from Ninth Plan. The weight of horticultural production including potato was 16.86 in 1996/97 which grew to 19.48 in 2001/02, and to 21.42 in 2006/07 (NPC, Periodic Plans).

PROSPECTS FOR DEVELOPMENT

- Nepal has become a member of SAPTA (South Asia Preferential Trading Agreement) since 1993, BIMSTEC (Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation) in 2003, SAFTA (South Asia Free Trade Area) in 2004, WTO (World Trade Organization) in 2004. It has supported the export of Nepalese products.
- Education level and nutrition knowledge has increased significantly. Adult literacy increased to 57 percent in 2011 as compared to less than five percent some 60 years ago. It has increased people's awareness about the importance of fruits and vegetables in daily diet thereby increasing demand for fruits and vegetables.
- Demand for quality fruits and vegetables will be much stronger as the middle income group grows. There will be increased demand for raw horticultural products together with the expansion of processing industry sector.
- As prioritized by the government, opportunity to establish joint ventures with foreign companies has also been open. It has become more feasible with the growing financial institutes in Nepal coupled with the opportunity of introducing modern technology and management system from developed countries.
- Increased per capita income overtime and adoption of western culture has increased demand for floricultural products compared to yesteryears (Gauchan et al, 2009). Fresh cut flowers are used for decorative purposes such as vase arrangements and bouquets at formal events; designs for weddings and funerals; gifts on occasions.
- Along with availability, fruit consumption culture has increased in Nepal. There are several fruit shops and hawkers seen around the major cities.

- Local production of fruits is so low that nearly 70 per cent of the fruits consumed in the country accounting to annual 6 billion come from outside and beyond (Republica, 15 April 2014). Some fruits like lime and lemon in Kalimati wholesale market is supplied almost (95%) from outside (Dhakal et al, 2005).
- Most district headquarters are connected by roads. Now Remote districts (Manang, Mustang, Kalikot and Jumla) are also connected by road. It has opened new avenue for the promotion of high value horticultural products such as apple, walnut, almond, saffron, etc for both export and import substitution.
- Regarding export potential, Commerce Policy 2072 has identified Ginger – fresh and dry, Cardamom, Coffee, Tea, Vegetable and vegetable seed, fruits, flowers, as potential horticultural commodities for export.
- Access to technology and market information has made it possible to explore international markets and integrate Nepalese horticultural products into those markets.

Ways ahead

From a long-term experience and review of development efforts and opportunities for development, the following prospects appear as ways ahead.

Promotion of horticultural business: The commodities with high prospect are as follows.

- Apple - grading, branding, and product diversification from raw apple
- Citrus fruits - grading and branding to match the high demand in the international market
- Cardamom - drying, packaging, branding as per the demand in export market
- Tea - organic and green tea
- Coffee - organic and grain coffee
- Ginger - production zoning, certification, branding and drying
- NTFP - processing and value addition

- Vegetable seeds - processing, packaging, and branding

Promotion of foreign investment: Agro-based industries suitable for the attraction of foreign investment are as follows.

- Vegetable processing and marketing
- Floriculture production for import substitution and export promotion
- Fruit processing and export
- Vegetable seed production and export
- NTFP processing and export
- Tea Coffee processing and export
- Spices processing and export

Enhancing production: Production of horticultural products is being enhanced through the following interventions.

- Expanding production zone to diverse agro-climatic zones based on climate change patterns
- Adopting improved technology to increase productivity which is currently very low. For example, high density planting of apple, hybrid technology, tunnel technology, riverbed farming, etc. have already shown promising results.
- Adopting organic production technology to meet the growing demand for organic fruits and vegetables.
- Identifying niche markets and adjusting production accordingly. For example: Hybrid watermelons have taken the major institutional demand for watermelon. However, medium and small income group shoppers look for small sized watermelon (2-3 kg) for domestic consumption.
- Harnessing seasonal price variation in the Terai, India and Bangladesh markets during off-season and adjusting production accordingly.

CHALLENGES

- For various socio-economic reasons, fruit and vegetable intake in the community is low. Only a few percent (2.1%) people are consuming fruits and vegetables as recommended by WHO (Vaidya et al, 2013).

- Despite the fact that local fruits and vegetables are rich in nutrition, local fruits are vegetables are gradually replaced by improved varieties and imported costlier ones making it a bit difficult for common people to consume vegetables.

Box 1: Meeting a volume for export is a major problem

In the year 2001, about 12 metric ton of apple was exported from Jumla to Bangladesh via the Biratnagar custom port outlet. The Bengalis liked the Nepalese apples from Jumla. The following year, a team of few traders from Bangladesh reached Jumla and met with the apple producers there. They disclosed that the apples from Jumla are of better quality than Indian apples and hence they would like to continue importing apples from the Karnali region. But when the farmers were told of the quantity required (50,000 mt per year), they had their fingers crossed. It was not possible to produce that quantity of uniformly graded apples. The traders said they would not like to import apples to Bangladesh from several sources and hence, if Nepal can meet that supply level, they would resort to Nepal's export. The farmers were not organized enough to meet that supply level thus resulting in no export from subsequent years.

- It has been also reported that locally available fruits and vegetables are often wrongly considered inferior in terms of use of pesticides, artificial colour and ripening chemical. It has detracted nutrition conscious educated mass from consuming locally produced fruits and vegetables.
- Artificially coloured and flavoured juices (instant drinks) are becoming more common drinks rather than consuming fresh fruits, especially amongst children who should, in fact, eat fruit every day.
- Nepalese agriculture has been is grossly underfunded to address the research needs of time (Paudel, 2011).
- Cultural taboos have also affected vegetable production and consumption in Nepal. Some people think that vegetables should not be consumed if the person has an illness. Lactating mothers are sometimes advised to avoid green vegetables lest they harm the mother and her infant. Some people feel a loss of dignity if they

grow and sell vegetables (Schnelle, 2012). Vegetables are credited for adding taste and variety but are not necessarily regarded as being rich in nutrients (Thapa and Paudyal, 2009).

- Improper intercropping in orchards is still a negatively contributing to orchard health and fruit yield. For example, in Solukhumbu, apple orchards are generally intercropped with maize, wheat, potato and vegetables. Damage to the plants and root zone of fruit trees while ploughing the field for intercrop plantation is conspicuous for poor orchard health (Shahi, 2005).
- Though many district headquarters are connected by road transportation network, the horticultural production pockets are yet to be connected by roads, Although APP emphasised connecting potential production pockets by roads, the budget allocated for agricultural roads have been diverted to connect townships (FAO, 2010).
- Meeting a volume for export is a major problem. As shown in Box 1, Nepali traders could not export apple just due to not meeting the required volume for export.
- Policy issues were also encountered. For promoting a new variety, GON has limited ability and a long process to approve new seed varieties. The Competition Promotion and Market Protection Act of 2007 is in place. However, this law needs to be implemented in practice to deal with disputes in transport syndicates. There is a lack of Contract Farming Act to promote plantation crops such as tea, coffee, fruits, etc. The existing policy of supporting communities/ cooperatives to construct collection centre/marketing structure is yet to be made favourable to promote horticultural markets. This is because farmers cannot avail land in a place where marketing can really take place and the place where farmers can avail land, marketing does not take place
- Availability of planting material was also limited. In many cases, even when planting materials were available, quality of planting materials was low (FDD, 2013)
- Despite the increased knowledge of the harmful effects of pesticides, due to weak monitoring, indiscriminate use of pesticides

has increased beyond the threshold level. For example, in Terai district such as Siraha, Dhanusha 67 percent farmers spray their crop more than 8 applications and in hill district such as Kavre farmers spray their vegetable crops such as tomato 6-7 times with Endosulfan against tomato fruit worm (Helicoverpa armigera) and more than 5-6 times with Dithane M-45 against late blight in a single cropping season (GC, PPD). In crops like tomato from Kavre, pesticide residue has been found above the Acceptable Daily Intake (ADI) or maximum residue level (MRL) (Aryal, ED).

- There is still a high postharvest loss (20-30% in fruits and 30-40% in vegetables) due to lack of grading, inappropriate packaging techniques and materials, and means of transportation.

CHALLENGES AHEAD

Enhancing production: Major challenges ahead in production include the following.

- Conducting problem-based research
- Providing research-based production technology
- Enhancing managerial skills of the producers
- Enhancing access to financing with adequate consideration of gestation period

Improving physical infrastructure:

- Increasing cold storage facilities, especially zero-energy cold storages in remote areas
- Increasing road network facilities to connect major production pockets
- Increasing marketing infrastructures at strategic points
- Promotion of alternate energy to address the problem of frequent load shedding

Enhancing marketing:

- Promotion of cooperative to solve the problem of scattered and small production units
- Promotion of horticultural business providers to address the

business service needs
- Facilitation to establish appropriate linkage and coordination
- Promotion of contract farming system to address the problem of fragmented and small land size
- Facilitation to obtain price information and market integration
- Enhancing farmers' capacity to analyse the market signals

Promotion of processing:
- Promotion of production zones for processing to ensure reliable supplies of raw materials in terms of quality and quantity
- Facilitation to link small producers with processing industries
- Quality standardization and certification
- Technological intervention to reduce the cost of production to address the problem of high competition due to import of cheap products
- Enhancing access to finance by introducing a system of pledging processed products in the storage

Reducing postharvest losses: Major intervention areas include the following.
- Enhancing farmers' capacity on appropriate harvesting techniques
- Improving packaging materials and packaging techniques
- Enhancing farmers' capacity on pre-cooling (for removal of field heat in leafy vegetables and beans), grading (ginger, apples, mandarins), packaging (apples and pears, tomato, cauliflower, peas and beans) and transportation
- Promoting multi-chambered cold storage facilities for fruits and some vegetables such as carrot and cabbages in the major consumption market centers

REFERENCES

Aryal, A. Entomology Division. Review on the pesticide residue works in Nepal.

Awasthi, B. D. 2007. Relevance of market information system to environment Protection. *The Journal of Agriculture and Environment* (8): 46-54

Dhakal, D. D., K. M. Tripathi and S. Bhattarai. 2005. Marketing survey of acid lime and hill lemon in *Nepal. J. Inst. Agric. Anim. Sci.* (26):107-116

DOC. 2014. Statistics of Cooperative Enterprises,. Department of Cooperatives, Kathmandu

FAO. 2010. Pricing Policies for Agricultural Inputs and Outputs in Nepal. FAO, UN House, Nepal

FDD. 2012. Annual Progress Report . Fruit Development Directorate, Kirtipur.

Gauchan, D. P., A. R. Pokhrel, M. Pratap, P. Lama, 2009. Current Status of Cut Flower Business in Nepal. *Kathmanu University Journal of Science, Engineering and Technology*. (5) 87- 98

G.C., Yubakdhoj . 2012. Status of Pesticide Use In Nepal and Future Strategy for their Safe and Alternative Uses, Improvement, and Production in Nepal. *Hort Science* 47(7)

Paudel, M.N. 2011. Keynote Address at Seventh Agronomist Workshop. Agronomy Society of *Nepal,* Khumaltar, Lalitpur

Schnelle, M. A. 2012. The Future Potential of Horticultural Plant Discovery,

Shahi, R. D. 2005. Identification of problems associated with apple cultivation and possible measures to overcome them in Himalayan project areas of Solukhumbu district. Himalayan Project (Danish)

Thapa, G.B. and D. Paudyal. 2009. 4 May 2011. www.avdrc.org/pdf/dynamics/Nepal.pdf.

Vaidya, A. N. Oli, U. R. Aryal, D. B. Karki, and A. Krettek. 2013. Disparities in Fruits and Vegetable Intake by Socio-demographic Characteristics in Peri-urban Nepalese Adults: Findings from the Heart-Health Associated Research and Dissemination in the

Community Study, Bhaktapur, Nepal. *Journal of Kathmandu Medical College*, (2). No. 1, Issue 3, Jan.-Mar., 2013

VDD, 2014. Vegetable varieties. Vegetable Development Directorate (VDD), Khumaltar, Lalitpur

VDD, 2013. Annual report 2013. Vegetable Development Directorate (VDD), Khumaltar, Lalitpur

FDD, 2013. Report on annual progress and statistics. Fruit Development Directorate (FDD), Kirtipur, Kathmandu

MOF, 1998. Economic Survey 1998. Ministry of Finance (MoF), Singhdurbar, Kathmandu

MOAD, 2014. Statistical information on Nepalese agriculture. Ministry of Agriculture Development (MoAD), Singhdurbar, Kathmandu

HORTICULTURE IN SAARC COUNTRIES

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ABSTRACT

SAARC, a regional cooperation organizationestablished in 1985 with its headquarter in Nepal, consists of eight member countries namely Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. It aims at working together in a spirit of trust and friendship for accelerating socio-economic development in member countries. These countries have their own natural topographical and climatic conditions based on which a number of horticultural crops such as fruit, vegetables, roots and tubers, ornamental, medicinal and aromatic plants, plantation crops, spices and others are grown. This region has enormous opportunity to grow tropical, sub-tropical and sub-temperate to temperate horticultural crops of commercial importance. All these countries are trying hard to improve the income, nutritional, financial and food security of millions of poor people. Horticulture could be a vital sector to bring positive change in the socio-economic life of the millions of people living in SAARC countries. However, there are still numerous problems being faced by these countries and they have not been able to fully exploit the enormous potentiality of horticultural development in the region, and with the development of regional co-operation among each other, there is every chance to increase the productivity of commodities to a substantial amount. Therefore, there is an urgent need to deal with cooperative activities in the following fields: i) exchange of new germplasm in developing new crop varieties; ii) seed policies to facilitate the development and importation of hybrid seeds; iii) exchange of experts in different fields; iv) joint ventures in seeds and planting material production; v) joint ventures in processing industry; vi) exchange of technologies in production of farm machinery and equipment; vii) training programs on hybrid seed production, post-harvest handling, processing, socio-economic data collection and analysis; viii) setting up of a regional information network, etc.

BACKGROUND

The South Asian Association for Regional Cooperation (SAARC) is an organization established in 1985 with the objectives of providing platform for the peoples of South Asia to work together in a spirit of friendship, trust and understanding. It aims to accelerate the process of economic and social development in Member States (Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka). While poverty and hunger remain one of the major challenges before the region, agriculture remains the predominant sector of the region's economies. The region is home to 1.567 billion people (23.7% of global population). The principal reason for high incidence of poverty in the region is low per capita income and inequitable distribution of income: with 23.7% share in global population, the region has only 2.62% share in global income. A vast majority of population in the region lives in rural areas and depends upon agriculture for livelihood and sustenance. Agriculture development is, thus, very critical to reducing poverty, improving nutrition and food security and promoting sustainable and inclusive growth of the regional economies.

Per capita Gross National Income (GNI) in the eight Member States ranges from $345 to $3,277: lowest GNI is in Afghanistan while the highest is in Maldives. Per capita GNI in India and Pakistan is around US$ 1,000. Low level of income is one of the primary reasons for wide prevalence of poverty and severe under-nutrition. Poverty in the region varies between 21% - 53% while 17% - 30% of population in different countries does not consume minimum level of globally recommended dietary energy (SAARC agriculture vision 2020, SAARC Agriculture Center).

Agriculture farming in South Asia is dominated by small land holdings i.e. average size is below 0.5 ha in Bangladesh, below 1.0 ha in Sri Lanka and Nepal. Theaverage farm size is 1.41 ha in India and 3 ha in Pakistan. Except in Pakistan, holdings below one hectare account for more than 60% of total farm holdings. Farmers in the region depend heavily on rain-fed agriculture. Of arable lands, irrigated land is around 33% in India, 39% in Sri Lanka, 47% in Nepal, 56% in Bangladesh and 90% in Pakistan (SAARC AGRICULTURE VISION 2020, SAARC Agriculture Center).

However, new opportunities are arising on account of choice of technology, change in demand patterns, surge in value chains and supermarkets, revolution in information and communication technology, institutional innovations, and globalization. Trade based on comparative advantage is also offering many opportunities. Agriculture research is getting increasingly capital intensive. These necessitate sharing of technology and resource in research, extension and infrastructure. Opportunities are also unfolding in green energy and bio-fertilizer. No productive activity can be sustained in the long run by overlooking the health of the production base and the producers. The Region thus needs to focus on farmers and natural resource system or, agriculture production base i.e. land, water, and vegetation. Policies focused on farming ignoring their implications on the farmers are not sustainable. Growth and development of farming therefore must improve welfare of farmers.

Based on topographical and climatic suitability in these countries, a number of agricultural crops and wide varieties of horticultural crops including fruits, vegetables, roots and tubers, ornamental, medicinal and aromatic plants, plantation crops, spices and other are grown. All these countries are trying hard to improve the income,nutritional, financial and food security of millions of poor people. Horticulture could be a vital sector to bring positive change in the socio-economic life of the millions of people in SAARC countries. The country-wise present status of horticulture development in SAARC region is discussed as below.

Afghanistan:

Afghanistan lies in central Asia covering an estimated area of 647,500 square kilometers of land area and reportedly 248,187 ha of water bodies (2,482 sq km, some 1.0% of total land area). Completely landlocked, it is surrounded by Tajikistan, Uzbekistan, and Turkmenistan in the north, Iran in the west, Pakistan in the south and southwest, and China in the northeast. Its area is composed of mountainous and desert areas where the Iranian Plateau borders the mountains of Central Asia. The Hindu Kush mountain range splits Afghanistan from east to west. The country is divided into thirty provinces, each province consisting in a number of districts. Within these districts most families live within villages. Rural households make up some 80% of the total national population of approximately 27 million.

Most of Afghanistan has a sub-arctic mountain climate with dry cold winters, except for the low lands, which have arid and semi arid climates. In the mountains and a few of the valleys bordering Pakistan, a fringe effect of the Indian Monsoon, coming usually from the southeast, brings moist maritime tropical air in summer. Annual rainfall ranges from 100 mm to 400 mm. In Afghanistan, summers are hot and winters can be bitterly cold. Summer temperatures reach as high as 490 C in the northern valleys. Mid winter temperatures, as low as 90 C, are common around the 2000m elevation level in the Hindu Kush. The climate in the highlands varies with elevation.

Agriculture has traditionally been the largest source of economic output in Afghanistan, engaging 80% of its population. Women and children as well as men have important roles in crop production, horticulture, and the rearing of livestock. Afghanistan's topography is of great influence in its agriculture, creating a large diversity of conditions for its production. Only some 12% of Afghanistan's land is arable, whereas 46% of it consists in permanent pastures and 3% of it forests and woodlands. Irrigated land is 3,300,000ha (1993 est.), equivalent to some 5.1% of Afghanistan's total land area. While landholding patterns in Afghanistan vary greatly, both between and within districts, sharecropping is common on irrigated lands.

Most farmers, an estimated 80%, own their land whereas the remaining 20% are landless but obtain a percentage of the harvest by reason of their labor. Larger land holdings can be found, however most farms are small in size and are managed at a family level. Although there are differences between provinces, farms between0.2 and 2 hectares appear to be the most common.

Horticultural crops are an important part of the agricultural sector in Afghanistan.In the late 1970s, horticulture accounted for around 40% of the country's export earnings, though occupying only 6% of the total arable land and 12% of the irrigated land. Horticultural production declined rapidly during the war years, but began to recover significantly after 1992. A 1996 FAO survey found that 40% of orchards were less than 15 years old, indicating strong resilience among farmers, replanting and improving their orchards.A 1997 FAO Surveyindicates that an area of 140,000ha of orchards, 92,000ha of vegetables, and 5,000ha of sugar beet were planted in 1976. Horticulture crops consisted of significantareas of grapes, apricots, apples, almonds, walnuts, mulberries and melons. Raisins, driedapricots and almonds numbered among the country's major exports. Vegetables included largeareas of potato, which is a common element in Afghan diets as well as onions, tomatoes andeggplant. While horticulture crops covered only a small part of the total agricultural and irrigatedarea economically they were very important. They were primarily high value cash crops, whichat the same time broadened the nutritional base of the population.

Horticultural crops represented an important source of income (gross income per unit area isthree to seven times that of wheat, which make horticultural crops a good alternative to poppyproduction). Nevertheless, there is insufficient information on the current status of horticultureproduction. According to current information provided, the orchard area had declined from140, 000ha in 1997 to 70,000ha. During this period vegetable area had remained more or less constant at 90,00 ha.The major vegetable crops in Afghanistan include melon, watermelon, onion, potato and tomato,with these five species representing 87.4 % of the total area under vegetable cultivation. Major fruit crops are grape, almond, apricot, and pomegranate andapple, which cover a total of 95.9% of all orchards/vineyards.

In 2000, horticulture in Afghanistan suffered from a number of constraints some of which are lack of irrigation, low level of farm power, low level of crop diversification, lowtechnical standards, low level of post-harvest technology, high prices of agricultural inputs, weak government extension services, lack of market information and poor marketing channels.

Table 1. Average yield and average gross income of important fruit and vegetables

Crop	Yield (kg/ha)	Gross income per ha (US $)
Almond	2415	3179
Apple	10325	1814
Apricot	8890	1423
Grape	9065	1628
Peach	7630	1275
Pomegranate	9730	1424
cauliflower	29260	1833
Watermelon	14350	792
Onion 12845	12845	1109
Potato 14175	14175	1943

Source: FAO G: DP/AFG/96/004, Field Document 3 (2000)

Bangladesh

Bangladesh has an area of 147,570 sq. km with a population of about 160 million (2013). It is located in northeastern part of South Asia. It is a country having small hills, plains, coastal, wet and marshy lands. The climate is mainly tropical with temperature ranging from 5 to 25° C in winter and 20 to 40° C in the summer. Average rainfall varies from 1450mm to 4340 mm from north to south in the country. The total cropped area of the country is 13.70 mha. There are two cropping seasons, i.e. winter and summer. Most vegetables are grown in winter, while fruits in summer.

In Bangladesh, about 90 vegetables, 60 fruits and 25 spices are beinggrown. The major vegetables include potato, tomato, brinjal, cabbage, cauliflower, bitter ground, long-yard bean,pumpkin, okra, etc. Similarly fruits like mango, jackfruit, banana, pineapple, guava, papaya, lemons, litchi, etc. are important. In spices, chili, onion, garlic, turmeric, gingers, etc. and among flowers, ornamental plants, roses, gladiolus, dahlia, chrysanthemum, marigold, jasmines, etc. are grown. Vegetables, spices and fruits play a significant role in nutritional improvement, employment of labor force, food and financial security of the people of the country.The cultivated area under horticultural crops is about 0.7 m ha. Farmers grow horticultural crops both in homeland and farmland and the produce are sold in assembly markets, wholesale markets and retail markets. Overall the country is self-sufficient in many products but some sort of fruits and vegetables are imported from outside the country.

The following table depicts area coverage, yield and production of various horticultural crops.

Table 2. Area coverage, yield and production of spices and vegetables

Crop	2010-2011		
	Area (000 acres)	Yield (kg/acre)	Production(000 met. tones)
Spices	535	2757	1475
Winter vegetables	470	3386	1592
Summer vegetables	438	3369	1476

Source: MOA (2011)

Table 3. Area (acre) , average yield (kg) per bearing tree and production (x '000' MT)

Name of fruit	2010-2011		
	Area	Kg/tree	x'000' MT
Mango	68	69	889
Jack fruit	26	126	962
Papaya (ripe)	3	22	125
Litchi	5	60	66
Guava	12	32	271
Lime and Lemon	4	15	55
Pine-apple	37	5902 (kg/acre)	219

Source: MOA (2011)

Presently, Bangladesh is researching on a number of important vegetables especially on the areas of variety screening, variety development including the hybrids, colored vegetables, improvement of indigenous vegetables and generation of new techniques.

Bhutan

Bhutan is a small and extremely mountainous country with a surface area of 46,000 sq. km, located in the eastern Himalayas. It is bordered to the north by the Autonomous Region of China (Tibet) and to the east, west and south by India. The population is about 765432 and more than 90% of the population lives in rural communities comprising of a little over 67,000 households. Bhutan has extremely diverse agro-climatic conditions due to major differences in altitude and rainfall as well as in slope characteristics. Roughly, the country could be divided into four physiographic zones - the southern foothills, the middle river valleys, the mountain slopes and the high Himalayas. Based on temperature and rainfall the country could be further sub-divided into six agro-climatic zones - wet sub-tropical, humid sub-tropical, dry sub-tropical, warm temperate, cool temperate and alpine zones.Only about 3.4% of the land area, comprising 160,000ha, was used for seasonal and permanent crop production in 1998. Agricultural holdings are restricted to 12ha per family; almost all farm families have their own land.

Agriculture is the main source of livelihood for 69% of the population. Majority of Bhutanese farmers are small holder with an average farm size of 3 acres and practice a self-sustaining subsistence integrated farming systems. Despite its small size, the agro-ecology is diverse due to the large variation in altitudes. In agriculture, there are three key distinct farming systems which are the rice, maize and potato based system. Multiple cropping is a common feature of the small farmers. Citrus (Mandarin orange) plantation in the lower altitude and cardamom in the higher elevations are the main cash crops. In the sloppy dry land agricultural areas, maize, millet, mustard, several types of legumes, ginger and vegetables are the predominantcrops.A variety of vegetables are cultivated in the country mostly on subsistence level.Areas close to urban or accessible to motor roads produce substantial amount ofvegetables for sale. Some of the major ones are chilli, radish, turnip and potato. Vegetables have a comparative advantage as an off-season crop for theneighboring markets in India and Bangladesh.Potato cultivation has spread to all parts of the country and has become an important source of cash income to the farmers mainly in the west, central andin the east.

The total production of the potato for the year 2005 was 53,594 MT in which 23,766.54MT was exported.

Table 4. Fruit production and yield in kg per tree

Type of fruit	Production (m.ton)	Yield in kg per bearing tree
Apple	20752	37
Mandarin	60993	35
Peach	1649	39
Pear	1354	49
Plum	565	39
Walnut	474	24

Source: Bhutan RNR Statistics 2012, MoAF

Harvesting of fruit starts with the early variety of cherry (Seneka) by the end of May. Next are the early varieties of peach in June, followed by the Japanese pear variety Hosui. The earliest variety of apple to be harvested is the Japanese variety Hana-iwai in July followed by Nebuta. The main apple harvest season starts from August and extends up to October. The last varieties of apple to be harvested are the Japanese varieties Mutsu and Fuji and Delicious varieties.

The exploitation of the full potential of deciduous fruit cultivation in the country has not been possible due to the following constraints:

- Lack of clear-cut horticulture development policy and strategy in the past
- Inadequate transportation network, including lack of feeder roads to production areas.
- A weak horticulture research and extension system.
- Limited farmer knowledge of fruit production systems.
- Insufficient market information and market facilities.
- Low yields and poor quality fruits due to low level of management practices.
- Poor post-harvest practices and lack of storage facilities.
- Lack of small-scale processing facilities.

India

India is a big country with an area of about 31, 16,683 sq. km. It has a wide variety of climates and soil on which a large range of horticultural crops such as fruits, vegetables, ornamentals, medicinal and aromatic plants, spices, cocoa, etc. are grown. The fruit industry in India has made remarkable progress during the last 3 decades. The five fruits, i.e. mango, banana,citrus, guava and apple account for about 75% of total fruit production in the country. Other important fruits are grapes, papaya, pomegranate, ber, aonla, sapota, bael, and custard-apple. India has also made pivotal progress in the production of vegetable, tuber, ornamental, medicinal and aromatic plants. In addition, plantation crops and spices have also touched commercial values and India exports substantial quantities to foreign country. Overall, India has made a remarkable progress in the field of horticultural industry.

India with diverse soil and climate comprising several agro-ecological regions gives encouragement to horticulture crops where more than 28.2 million tones of fruits and 66.0 million tons of vegetable are produced that ranked next after Brazil and China in the World. Occupying 10% cropped area out of whole cropped area by horticulture ranked 2nd in the world for fruit and vegetable production. The share of India in the world fruit production is 10% and vegetable for 13.28%. Contribution of horticulture to GDP of agriculture is estimated to be more than 24.5%. Horticulture sector established in improving productivity of land generating employment, improving economic conditions of the farmers and entrepreneurs, enhancing export and provide nutrition security to the people. Food security which is the main objection the national agenda and this can be attained with providing nutritional and balance diet to population. Recommendation dietary allowance as per ICMR is 120g fruits and 250g vegetable per person per day. The availability of only 83g and 185g of fruits and vegetable respectively which is below the target level (Jadhav, 2013).

India serves as the home of various kinds of vegetables, fruits and holds a vital position in the field of production of fruits and vegetables amidst different countries of the world. Around 10% of the world production of fruits is accounted by India and leads the worlds in the production of Mango, Banana, Sapota and Acid lime, Grapes etc. Mango is the most important fruit in the country and banana comes in next. There is about 39% of mangoes production in India compared with the whole world production and with 23% of banana production India ranks first in world. Besides, India has leaped high in production and export of cashew in the world. Following table shows the statistical data of area under the cultivation of horticulture crop and production of horticulture crop of last four years.

Table 5. Area and Production of horticultural crops

Crops	2009-2010	
	Area(ha in)000	Production(m.ton in 000)
Fruit	6329	71516
Vegetables	7985	133738
Aromatic	509	573
Dry fruit	142	193
Spices	2464	4016

Source: NHB, www.nhb.nic.in/statistic

Some problems and constraints that exist in India are:

- Inadequate availability of disease free, high quality planting material.
- Slow dissemination and adaptability of improved high yielding cultivars/ hybrids.
- Lack of post harvest management technology and infrastructure.
- Weak database and poor market intelligence.
- Instability of prices, with no support price mechanism.
- Inadequate technical manpower / human resource in farming system.
- Poor credit supply, high rate of interest coupled with inadequate crop insurance scheme.
- Poor linkage between R and D sectors, industries and farming communities.
- Late implementation of government policies and schemes
- Absence of horticultural crop suitability map of India based on

agro-climatic conditions depicting most suitable areas for optimum productivity of a particular crop.

India has started improvement programs such as 1. Improving production, 2. Improving productivity, 3. Reducing cost of production, 4. Improving quality of products for exports, 5. Value addition, 6. Marketing and Export, 7. Price stabilization, 8. Strengthening of organizational support, 9. Human Resource Development and10. Addressing relevant policy issues.

Maldives

The Maldives Islands are an archipelago in the Indian Ocean with an agriculture land of 70 sq. km. and arable land of 4000ha with about 393988 populations. Maldives is the second smallest country in Asia and consists of 1087 islands in 19 atolls, of which only about 200 islands are inhabited. All of the islands are small and vary from tiny banks to islets, none exceeding 5 sq. miles (13 sq. km) in area. The Maldives climate is hot and humid with a mean temperature of about 27°C. Annual rainfall in the south averages 3807mm and in the north 2538mm. Agriculture is an important means of livelihood and for the island economies of the Maldives. The growing of crops in the home garden is an all year activity. Field cultivation is usually seasonal. The agriculture crops are mainly rainfed and a wide range of crops are grown in the country. The main fruits are bananas, papaya, mango, lime, guava, custard apple, pond apple, star apple, pomegranate, passion fruit, and water melon.Similarly, vegetables likechillies, brinjal, pumpkin, cabbage, tomato, grounds and leafy vegetables are grown.Plantation crops such as coconuts, bread fruit, and areca nut are also grown in the different islands (Maldives Agriculture statistics: Nationmaster.com).

Nepal

Agriculture sector has been playing dominant role in Nepal in providing national income and employment. It is the agriculture sector that acts as a single source for 65.6% of Nepalese people to provide them livelihood and earning. The contribution of agriculture sector in the national GDP is 38% in which contribution of horticulture sub-sector is estimated at 14% and out of this 14% fruit contributes 7%. The total area of Nepal is 147181 sq. km. of which cultivated agriculture land is 3091000ha and population is 26494504. In case of fruit crops, Nepal is bestowed upon by nature with varying agro-ecological situations that allow cultivating different types and cultivars of fruits successfully ranging from tropical to temperate fruits. Mango and bananas are the established commercial tropical fruit in country's hot valleys and plain areas, whereas citrus and apples are the prime commercial fruit of mid-hill areas and high mountain regions respectively. Especially, in Western and Mid and Far Western regions, Jumla and Mustang apples have made their specific identity for their qualitative characters like size, color, flavour, juice, crispiness and sweetness. Similarly, lime, suntala (citrus reticulata) and sweet oranges are extensively grown all over the mid-hill areas of Nepal for home and commercial consumption. Likewise peaches, plums, pear and walnut are the other deciduous fruit that grow extensively as wild and homestead garden fruit in hill and mountain areas all over the country including the Kathmandu valley. Persimmon and kiwi fruit are also showing commercial promise in certain districts. However, these fruits have not been exploited to their full potentiality to give expected income to fruit growers involved in their farming.

Fresh seasonal and off-seasonal vegetables have been categorized as high value crops and promotion of commercial production of fresh vegetables are essential for increasing the income of farmers, providing them with employment opportunities including the women farmers, and enhancing their accessibility to food security. Hence, in Nepal vegetables are specific agricultural commodity and its promotion could significantly drive rural growth in market accessible areas all over the country. The country has also laid emphasis on production of off-season vegetables exploiting the agro-ecological areas and adopting innovative technologies for producing and supplying different types of vegetables like cauliflower, tomato, cabbage and cucumber all the year round in city markets including the capital city Kathmandu. A large quantity of these vegetables used to enter from India to Nepal a decade ago, but now the situation has reversed. Besides fruit and vegetables, spice crops such as ginger, cardamom, garlic and turmeric are also grown. Oranges, some fresh vegetables, ginger and cardamom are export commodities also.

Table 6. Area (ha), production (mt) and yield (mt/ha) of different horticulture crops

Crop	Area	Production	Yield
Fruit	101480 (prod.area)	938731	9.25
Vegetables	246392	3301684	13.400
Potato	197234	2690421	13.641
Spices	47768	345252	7.23

Source: GON, MoAD (2013)

The above table depicts that horticultural crops of Nepal have considerably low productivity and reasons for this are attributed to various factors, some important ones are noted as lack of specic policies related to high value crops, poor private sector friendly environment, organizational weakness, lack of coordinati,lack of monitoring and evaluationl ,inadequate investment, lack of insurance policy, lack of mechanization, increase in cost of production, lack of competitiveness skill, weak value chain, climate change effect, poor research and extension support and weak infrastructures.

Pakistan

Agriculture constitutes the largest sector of Pakistan's economy. Majority of the population directly or indirectly depend on this sector. It contributes about 24 percent of gross domestic product (GDP) and accounts for half of employed labor force and is the largest source of foreign exchange earnings. It feeds whole rural and urban population. Realizing its importance, planners and policy makers are always keen to have reliable area and production statistics of agricultural crops well in time. Policy makers primarily need accurate and timely statistics for the important crops such as wheat, cotton, rice, sugarcane, maize etc. However, in recent years, due to persistent hikes in the prices of essential commodities like pulses, onions, potatoes, chillies and tomatoes these crops have also gained in economic importance. Pakistan offers variety in its landscape from the bread taking beauty of the high mountain ranges of the Himalayas of the North to the colorful intermountain valleys, rich irrigated plains, stark deserts and impressively rugged plateaus of Baluchistan. Pakistan has a total geographical area of 79.61 million ha out of which cultivated area is 21.41 million ha and population is 191.71 million. Pakistan is a sub-tropical and semi-arid country. The total water supply available in Pakistan is met from three main sources: rainfall, surface water and ground water. The mean annual rainfall varies from less than 100mm in the Sindh to more than 75mm in the foot-hills and northern mountains. About 60% of this rainfall comes during the monsoon season. Of the total 15.3 mha irrigated area, about 75% is irrigated through canals, 19% through tube-wells, 4% canals, 2% through wells and other sources.

The horticulture is a highly important sub-sector of Pakistan's economy. It covers fruits, vegetables, flowers and ornamental plants. The fruit crops include mango (Langra, Dasehri, Chousa, Sindhri, Anwar Ratol, Beganpali and Desi/Local varieties), citrus (Kinnow mandarin, Red Blood, Mausambi, Feutrel Early), grapefruit (Marsh Seedless, Shamber), lemon (Nrika Jaad, Kagfi lemon), dates (Asil, Fasli, Begum, Jungi, Mozawati,Ddhaki, Halini and Hussaini), apples (Golden delicious, Red delicious, Mashdi, Khamiri, Ambri), pomegranate (Gandahari, Bedana), guava (Sufaida, Allahabali), apricots (Abdullah Khani, Charmaghzi), peaches (Peshawar Local, Alberta, Robin, Early Ground, Florida King), plums (Fazal, Mannani, Santa Rosa, Stanley), and almond (Kaghzi, Non Peril, Besta). Some new crops are asparagus, kiwi, persimmon, ber (jujube), coconut, strawberry, cherry, and chicku (sapota).

Table 7. Area (ha), production (mt) and yield (kg/ha) of different horticultural crops

Crop	2010/2011		
	Area (ha in 000	Production (mt in 000	Yield (kg/ha)
Vegetables	252	3126.8	Not given
Fruit	836	6926.7	Not given
Potato	159.4	3491.7	21905.3
Tomato	52.3	529.6	10126.2
Onion	147.6	1939.6	13140.9

Source: Crop reporting services of Provinces

Sri Lanka

As per the National Income Estimates for the year 2009 the agriculture sector contributes about 13 percent to GDP and nearly half of the country's labor-force is engaged in agricultural activities. Sri Lanka has implemented agriculture based economic development policy in order to address the issue relating to the global economic slowdown and subsequent price hike in food commodities. A number of measures are being taken for developing agriculture sector particularly domestic food production, floriculture and export crop sectors for the purpose of achieving self-sufficiency at national level and ensuing food security.Sri Lanka is situated in the extreme south of India in the Indian Ocean. It covers an area of 65,610 square kilometers with population of 20359439. The horticultural sector of Sri Lanka normally deals with two important areas, i.e. crop and ornamental sectors. The production of fruits, vegetables, roots and tubers fall into the crop sector. The ornamental sector is concerned with the production of live plants, cut-flowers, leaves, bulbs, corms and tubers. The cultivation is mostly dominated by about 35 tropical, sub-tropical and temperate fruit cultivars (coconut, mango, avocado, pineapple, guava, papaya, wood apple, citrus, pears and passion fruit) and about 40 species of vegetables and root and tubers (bean, egg plants, pumpkin, beet root, cucumber, raddish, leaf vegetables, potato, sweet potato and tomato). The current average yields of most of the horticultural crops are very low in Sri Lanka compared to many other developing countries. The post harvest losses of fruits and vegetables are estimated to be around 30-40 %, which contribute to the high market prices. Reduction of post harvest losses reduces the unit cost of production, lower the prices and increase the farmer's income.

Table 8. Area and production of different horticultural crops

Crops	Area in Ha (2013/2014)	Production in Met.ton (2013/2014)
Fruit	104707	1296525
Vegetables	42921	620470
Potato	4105	67870

Source: Department of Census and Statistics, Sri Lanka, 2014.

It was concluded from foregoing discussion that each member of SAARC country has its own technology of horticultural advancement in terms of production of fruits, vegetables, floriculture and medicinal plants. However, with the development of regional co-operation among each other, there is every chance to increase the productivity of commodities to a substantial amount. Therefore, there is an urgent need to deal with cooperative activities in the following fields: i) Exchange of new germplasm in developing new crop varieties; ii) seed policies to facilitate the development and importation of hybrid seeds; iii) exchange of experts in different fields; iv) joint ventures in seeds and planting material production; v) joint ventures in storage and processing industry; vi) exchange of technologies in production of small farm machinery and equipment; vii) training programs on hybrid seed production, post-harvest handling, processing, socio-economic data collection and analysis; viii) setting up of a regional information network, etc.

REFERENCES

Afghanistan Statistical Yearbook, 2011/12. Ministry of Agriculture, Irrigation and livestock

Agriculture Statistics at a Glance, 2014. Government of India

Department of Census and Statistics, Sri Lanka, 2014.

Maldives Agriculture statistics: Nationmaster.com

M.T. Jadhav, Horticulture Development in India, Journal of Current Science, 1(1), 2013.

Pakistan Bureau of Statistics, Government .of Pakistan, 2010/2011.

Pema Dorji, Renewable Natural Resources Research Center, West Central Region, Bajo, Wangduephodrang, Ministry of Agriculture, Royal Government of Bhutan

Statistical Information on Nepalese Agriculture, MoAD, Government of Nepal, 2012/13.

The Statistical Yearbook of Bhutan, 2014.

Yearbook of Agriculture Statistics of Bangladesh 2011.

SIX DECADES OF FRUIT DEVELOPMENT IN NEPAL

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ABSTRACT

Growing fruit trees in the kitchen garden were practiced in Nepal since time immemorial. The establishments of the Horticulture Section under the Department of Agriculture in 1955 and 13 Horticulture Farms at different agro-ecological zones of the country with the support of Indian Cooperation Mission (ICM) were very important steps of modern fruit development in Nepal. The Department of Horticulture that was created in 1967 had lost its identity in 1972. Then Fruit Development Division and National Citrus Development Program were created in the same year. Fruit development programs were also supported by many donor-funded projects during the period of 1970 to 1990. Despite the fact that the number of manpower has increased from one horticulturist in 1941 to a few hundred at present, there is erosion in the quality of manpower. Furthermore, due to poor resources and opportunities in the horticulture farm/centres, horticulturists do not like to work in the horticulture farm/centres these days. In the last four decades, area was increased by 11 times whereas increase in production was 12 times. Fruit sapling production and distribution was a public sector business, before 1975. The government initiated the establishment of private nurseries from 1975. Today more than 90 percent share of total fruit sapling production and distribution is met by the private nurseries. Despite of these changes, the quantity and value of importation of fruits is increasing in recent years due to the rate of demand increasing faster than the increasing rate of production, resulting in a wider trade deficit. Research back-up is very weak and progress on the development of grading and packaging facilities is very poor. NGOs and other development partners are least interested in fruit development as most of the fruit crops take long time to give returns or results.However, most of the fruit crops are environment friendly and some of these crops can be successfully grown even in the undulating and earthquake-induced cracked lands.

INTRODUCTION

Fruits and flowers are very important for the everyday life of human beings. Hindus regard the Bael tree (Aegle marmelos) as a plant of Lord Shiva and the wood and bark used in the ritualistic pooja or worship. Ehee or Bel bibah is a cultural ceremony, in which a Newari young girl is said to have married to the sacred fruit of Bael, and she is not considered widow even after death of her husband (Shrestha, 1998). Coconuts and other fruits are offered to God during worships. Mango leaves and banana plants and leaves have similar religious values. Different types of fruits in the baskets are being prepared to offer to the Gods in the temples. It is also a common culture to carry some fruits when visiting a sick person; this may be due to the nutritional value of fruits. All these indicate that growing fruit trees in the kitchen garden was practiced in Nepal since time immemorial but their commercial cultivation started only after the establishment of horticultural institutions in the country during sixties (Shrestha, 1993) and celebration of agricultural year in 1975. In this article, development made in institutions; manpower; infrastructure; area coverage and production; nursery plant production; research; policies, plan and programs are briefly reviewed.

INSTITUTIONAL DEVELOPMENT

Although introduction of fruits and their cultivation was started from the Pre-Rana Regime, the necessity for fruit cultivation on a scientific basis was realized only after 1940 when an Indian fruit expert assisted in scientific fruit cultivation. Horticulture units were established at Agriculture Station of Kakani in 1948 and Parwanipur in 1959. The establishment of the Horticulture Section under the Department of Agriculture in 1955 was also an important step for promotion of fruit development in the country. One Fruit Preservation Unit established at Kirtipur Farm in 1961 has been upgraded to the Department of Food Technology and Quality Control in the year 2000.The establishment of 13 Horticulture Farms by the government at different agro-ecological zones of the country with the support of Indian Cooperation Mission was the foundation of modern fruit development in Nepal (MOA, 1990). These farms were established with the following mandates:

- Establishment of progeny orchards at horticulture farms.
- Introduction and evaluation of exotic varieties of fruit crops.
- Production technology development and verification.
- Production and distribution of quality planting materials.
- Identification of some production pockets for different fruits.
- Providing technical service in orchard establishment and management.
- Conducting trainings for field level technicians and fruit growers.

The Indian bilateral assistance program was implemented during 1960-1973. A separate Department of Horticulture (DoH) was created in 1967 to initiate horticulture development all over the country in an organized and planned ways. The department was responsible for both research and development. But the Department of Horticulture had no extension network at the grass root level. Both research and extension activities used to be carried out by the horticulture farms/ centers within their limited command areas. Research activities were focused on introduction and selection of fruit crop varieties, root stock selection, development of propagation methods under local condition, and orchard establishment. Extension activities were focused on site selection, planting material distribution and demonstration on orchard layout.

Little attention was given on orchard management. Like other programs, fruit development programs were supply driven and the Department of Horticulture was solely responsible to implement them. Institutions at the private sector were not established. However, the Department of Horticulture lost its identity in 1972 with the merging of five departments to create the Department of Agriculture. Then under this Department of Agriculture, Fruit Development Division and National Citrus Development Program were created in the same year. DADOs of the 75 districts were given responsibility of horticulture extension along with other regular programs.

After the celebration of the "Agriculture Year" in 1975, there was a paradigm shift in production function of horticulture. Private fruit nurseries were then established all over the country to produce fruit saplings locally. Because of the proactive roles played by the National

Citrus Development Program, both research and extension activities in citrus were implemented in all mid-hill districts of Nepal effectively and intensively. Emphasis was given to train farmers in nursery and orchard management.

The Hill Agriculture Development Project (1977-1980) implemented with the technical assistance of FAO, strengthened horticulture farms of Kirtipur and Jumla by providing horticultural equipment and exotic varieties of warm-temperate and temperate fruit crops. In 1982, a post of Deputy Director General (DDG on horticulture) was created in the Department of Agriculture realizing the importance of horticulture in the country. In the context of organizational development, a major step was taken in 1985 by creating the National Agricultural Research and Services Center (NARSC) to undertake research activities separately. In the same year, the Horticulture Development Project was commenced with its project office at Horticulture center Kirtipur. This project promoted Junar in Ramechhap and Sindhuli, pear and chestnut in Kathmandu, Bhaktapur and Lalitpur and grapes in Banke and Bardiya. Variety introduction, variety selection, fruit quality assessment, packaging of production technologies, demonstration of production technologies and training were the main activities undertaken by this project. The demo-farm approach of technology transfer and long term crop cycle based training for field level technicians introduced by this project were very successful innovations and hence, suggested to scale-up in the future programs of fruit development.

In 1988, another project, known as the Hill Fruit Development Project (HFDP), was implemented in the 11 districts of the Eastern Development Region with the financial and technical support of the ADB. The main objective of this project was to increase fruit production and productivity without degrading environment of the hill areas. Despite the noble objective of the project, this project could not be successful due to design and implementation problems. This project was in implementation for a period of eight years (1988/89-1996/97). The contributions of Integrated Hill Development Project (1975-1985) in Dolakha and Sindhupalchok, Pakhribas Agriculture Center in eastern hills and Lumle Agriculture Center in western hills to fruit development were also quite significant, particularly in variety evaluation and selection, nursery management, and orchard establishment.

Fruit development programs were thus supported by a few donor funded projects during the period of 1970 to 1990. However, the transfer of research responsibility for fruit crops to NARC posed a major problem as most horticultural farms/stations and trained manpower remained with the department. Furthermore, the NARC was cereal crop biased while prioritizing the research programs. This resulted in poor allocation of research budget in fruit crops. Similarly, DOA's extension service was also cereal crop biased and the staff of DADO offices used to give little attention to fruit development programs.

Given the importance of horticultural crops including fruits in the national economy, the Department of Horticulture (DOH) was re-established under the Ministry of Agriculture in 1990. 75 District Horticulture Offices (DHOs) were proposed to be created under this department but only 30 DHOs could be established. The DOH started to function with these 30 offices along with two technical divisions (fruit and vegetables), five commodity programs and 23 farms/stations. The National Agricultural Research and Services Center was given autonomy to exercise its research functions independently and was renamed as the Nepal Agricultural Research Council (NARC) in the year 1991. But horticultural research in general and fruit research in particular was kept at low profile even by this autonomous NARC. Furthermore, the lingering issue of handing-over of the farms could not be resolved for a long period and this affected fruit crop research negatively.

After the restoration of democracy in 1990, four departments under the Ministry of Agriculture including the Department of Horticulture were again merged to create the Department of Agriculture Development. A horticulture unit was then established in each DADO office and provision was also made to have one horticulture development officer in each district. Thus, in this restructuring extension network was extended to all 75 districts for horticulture development. Similarly some more officer level posts were also created in the ministry, the department and training centers. The Fruit Development Section was promoted to the Division with more responsibilities and manpower. In this context, the Tea and Coffee Development Section was established and placed under this division. But the National Citrus Development Program was demoted to a section of the Fruit Development Division and shifted to Kirtipur from Paripatle, Dhankuta. However, it has been again promoted to the original position of National Program and the Fruit Development Division has been renamed as Fruit Development Directorate in 2007.

After 1990, the democratic government of Nepal took several initiatives in private sector that led economic development. The new cooperative law was enacted changing state directed Sajha to more autonomous Sahakari. The department of agriculture adopted group approach of extension to cover more farmers and areas. Since then many cooperatives and groups are formed and functioning in fruit development. In some important fruits, such as Junar, mandarin orange and apple, cooperative federations have also been formed to promote their production and marketing.

With the objective of import substitution of these fruits, the government has implemented the Lime Mission Program from the fiscal year 2007/8 and the Apple Self Reliance Program from the fiscal year 2013/14. The Citrus Orchard Rejuvenation Program has been implemented from the fiscal year 2013/14 in order to combat the citrus decline problem. The Lime Mission program was discontinued after the fiscal year 2013/14, however, the Apple Self Reliance Program and the Citrus Orchard Rejuvenation Program are having a good impact on quality fruit production. There are a number of other related institutions and projects which are involved in fruit development in Nepal. The Hill Agriculture Research Project (1997-2004) and the National Agriculture Research and Development Fund established in 2001 have supported fruit development programs through the competitive grant system. Similarly, Project for Agriculture Commercialization and Trade (commenced from 2010), High Value Agriculture Project in Hill and Mountain Areas (commenced from 2010), Commercial Agriculture Development Project (commenced from 2009), Raising Incomes of Small and Medium Farmers Projects (commenced from 2012) and High Mountain Agriculture and Livelihood Project (commenced from 2011) have also supported some fruit development projects selected on competitive basis. The problem with these institutions is that they have kept fruit development projects in low profile.

NGOs (both national and international) are also showing least interest in fruit development due to, probably, long gestation period of most of the fruit crops. In recent years, private organizations such as FNCCI, AEC and DCCI, are also supporting fruit development programs as the key partners of the fruit value chain.

MANPOWER DEVELOPMENT

Though Mr. Satya Lal Ranjitkar was appointed as the first Fruit Culture Specialist by the then Chief Saheb Padma Shamsher in 1941, the work of Mr. Dibya Bahadur Basnyat (B.Sc.Ag.) in fruit development should not be forgotten (Shrestha, 1998; Shrestha, 1993). He introduced and planted apple, mosambi, pineapple, banana and persimmon in Balaju and Godawari. Mr. Shambhu Man Singh, who is now over 90 years of age, was the Director of the Horticulture Department from its establishment year of 1967 to merging period of 1972. Up to the late sixties, the number of horticulturist working in the country was within the range of 15-16. After 1970, many agriculture graduates returned to Nepal after completing their B. Sc. Ag. Course in different universities of India under the Participant Program (USAID) and majority of them joined the Department of Agriculture; few of them started work in the Ministry of Education and Agriculture Development Bank (HDP, 1995). The number of agriculture graduates who started their jobs as horticulturists during the seventies was about 20. Since then the number of horticulturists working in the country is in increasing trends. The number of trained manpower in horticulture working under the ministry of agriculture during 1990 and 2014 are shown in the following table.

Table 1. The number of trained manpower in horticulture working under the Ministry of Agricultural Development

Level of manpower	1990			2014		
	Central offices	District offices	Total	Central offices	District offices	Total
Officer level (G.class III-I)	109	14	123	146	75	221
Assistant level (JTs/JTAs)	191	68	259	191	71	262
Total	300	82	382	337	146	483

Source: MPHD, 1990; MOAD, 2014; DOA 2014.

Besides the manpower shown in the above table, a significant number of horticulturists are working in non-governmental organizations. However, it can be assumed that horticulturists dedicated to fruit development are few in number.

Despite the fact that the number of manpower has increased from one-horticulturist in 1941 to few hundreds at present, there is erosion in the quality of manpower. The senior horticulturists working in fruit development have now been phased out, while young horticulturists have little interest to work in fruit crops. Trained manpower has not been retained and there are several instances where a staff member who has been trained on a particular subject matter is transferred to a job with a different set of responsibilities even before the expertise gained through training intervention can be utilised or transferred into the system. Due to poor resources and opportunities in the horticulture farm/centres, horticulturists do not like to work in the horticulturefarms/centres these days.

INFRASTRUCTURE DEVELOPMENT

The basic infrastructures required for fruit development in a sustainable way are: (1) transportation facilities, (2) irrigation facilities, (3) value addition facilities, and (4) marketing facilities. Transportation is the key link in the value chain of any commodities including fruits. Road transport is the only possible means of transportation of fruits in Nepal. There was no motorable road in Nepal during the early forties. Now the scenario had been changed. At present, the total length of all kinds or road is 25115 km (MOF, 2010). There are three east west highways extending from the eastern border to the western border. The number of north-south roads is more than a dozen. Such road network has provided an opportunity to expand areas under fruit crops manifold. For example Karnali High Way has now shown its impact on the market access of apple production of those areas. Road transport in Nepal consists of mainly trucks owned by the private transport companies. However, there are still many fruit production pockets having no access to road. Fruits from such production areas are transported by the porters using Dokos as the means of transport. In some hilly areas mules are used to transport fruits from production areas to the road heads. In the terai, bullock carts are used where there is nomotorable road access.

Regarding irrigation facilities, fruit crops in Nepal are generally grown under rain fed conditions. But some commercial farmers have started to establish plastic ponds, drip or sprinkle irrigation facilities in their orchards. In hilly and mountainous areas, cellar stores have now becoming popular to store fruits in the production areas especially for apple and citrus. Besides, there area few cold stores in the vicinities of highways and wholesale markets. In recent years, many collection centres are developed in the production areas and wholesale market facilities at the strategic points. For example, wholesale-cum retail market facilities are developed in Kathmandu, Narayangadh, Butwal, Kohalpur, Attariya, Pokhara, Dhalkebar, Dharan and Birtamod. Fruit processing facilities are also developed in many strategic points by private entrepreneurs and cooperatives. But progress on the development of grading and packaging facilities is very poor. Hence grading and packaging operations are manually done.

FRUIT PRODUCTION AND GOVERNMENT POLICIES

Area , Production and Productivity

Fruit cultivation in scientific ways was started only after the 1960. In 1967, the area under different fruit crops was estimated to be 2000ha (Shrestha, 1993). The area, production and productivity of different fruits from 1970 to 2014 are as shown in the Table 2.

Table 2.Area, production and yield of fruits

Year	Area (000 ha)	Production (000 MT)	Yield (ton/ha)
1970	13	80	6.0
1975	33	254	6.5
1980	42	274	8.3
1985	51	343	9.0
1990	63	442	9.0
1995	59	398	10.1
2000	70	447	9.62
2005	89	553	9.99
2010	107	707	10.00
2014	148	965	8.77

Sources: MOAC, 2014 and FDD, 2014; Note: Yield is calculated based on the productive area.

In all the periodic plan periods, both area and production were increased except during the eighth plan period (1992-1997) in which both area and production were decreased. The unusual figures of this period were the results of data adjustment which was made in 1993 based on the mortality of plants in the orchard. Productivity was stagnant or increased very slowly during all plan periods. The table 2 shows that the area was increased by 11 times in the last 44 years, but production increased by only12 times. Productivity increased by 1.5 times.It clearly indicates that the main reason for increased production was the area expansion.

Figure 1 shows the area of these three categories of fruit crops since the year 2000; area of all these crops are increasing, however, the rate of increase in area is faster for summer fruit crops in recent years (after 2009).

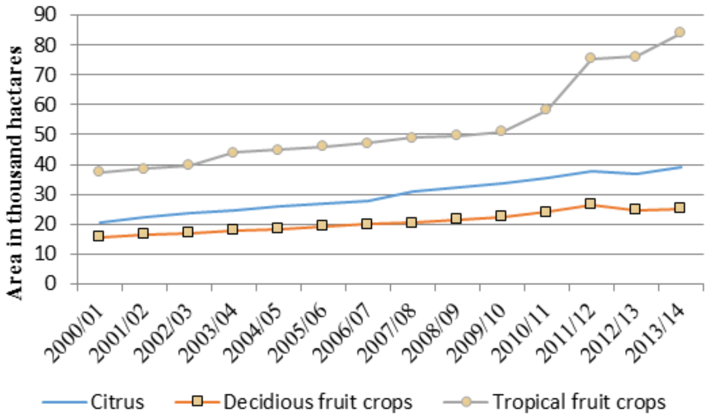

Figure 1: Area of major category of fruit crops in hectares in the FY 2013/14.

Source: FDD, 2014.

Recently, some fruit crops namely strawberry, avocado and kiwi are emerging as the potential crops in warm temperate and sub-tropical areas of eastern and central regions and olive in drier mid-western and far western hilly regions of the country.

Fruit Sapling Production

Review of the fruit plant production system in Nepal revealed that the establishment of fruit nurseries at Chhauni, Balaju and Godawari in 1937, establishment of horticulture farms during 1960s and celebration of the Agriculture year in1975 were very important milestones in fruit sapling production. Asexual propagation of fruit plants (apple, pear, peach, plum etc) was started after the establishment of these three nurseriesat the government level. . Researches were carried out to find out appropriate method and time of propagation under Kathmandu conditions. In terai, grafted plants of mango used to be imported from private nurseries of India located near the border. When many other horticultural farms were established during the sixties, fruit plant production and distribution programs were implemented by the government through these farms. Thus, fruit plant production function was the public sector function up to 1974 and there was always shortage of fruit plants in the country.

Realizing this fact, the government initiated establishing private nurseries in intensive fruit production pockets from 1975. Nursery owners were trained in different aspects of fruit plant production and they were then supported to establish the nurseries. Then private nurseries were established in many parts of the country and the function of fruit sapling production was gradually shifted from the government farms to these nurseries. In 2014, the number of registered private fruit nurseries in Nepal was 32 for citrus, 161 for winter fruits and 53 for summer fruits (FDD, 2014). About 2.5 million fruit saplings are produced and distributed annually, and the share of private nurseries in it is more than 90 percent(Figure 2).

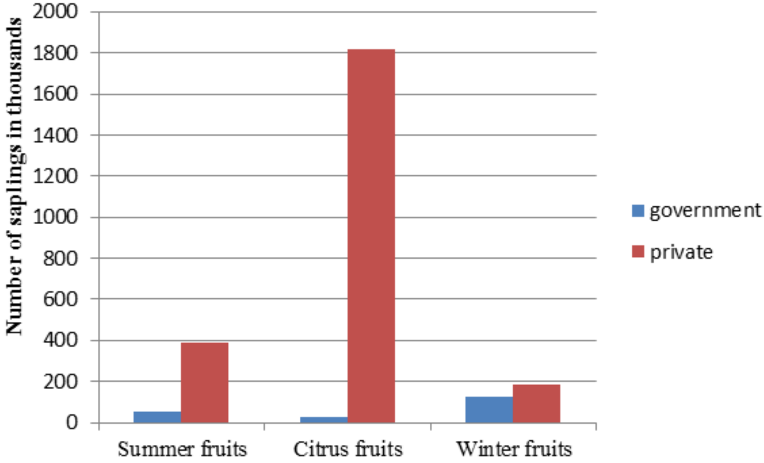

Figure 2: Share of government and private nurseries in fruit sapling production in the FY 2013/14

Source: FDD, 2014.

Government Policies, Plan and Programs

Many efforts have been made in developing favorable plans to harness the potential of horticulture in Nepal since the fifth five-year plan (1975-80). The fifth five-year plan concentrated on strengthening of organization and production oriented researches. It gave high priority to farmers' problem solving adaptive researches. In the sixth five-year plan (1980-85) efforts were made to fruit development in road accessible areas. The seventh five-year plan (1985-90) also directed fruit development programs along the highway corridors and densely populated areas. The prioritized fruit crops for commercial production were mango, banana, mandarin orange, sweet orange, apple, pear and walnut. Priority programs were launched in 20 districts for citrus, 15 districts for mango, 11 districts for apple, 10 districts for pear and 7 districts for walnut. In order to encourage farmers in fruit production, the government provided interest subsidy on the credit for fruit farming. Then the government felt a need for a long term plan for horticulture development and a 20-year Master Plan for Horticulture Development (MPHD) was developed with technical and financial support of the Asian Development Bank. The MPHD was developed based on the concept of agro-ecological zones. According to this plan, suitable fruit development programs were to be formulated on the basis of 15 horticultural units.

The MPHD could not get approval.If MPHD was approved and programs were implemented as per its suggestions, the amount of money we are now expending every year for import of fruits, would not only have been saved, but could have earned every year by exporting fruits. The eighth 5-year plan (1992-97) gave emphasis on bottom-up planning and intensive fruit development program in road corridors without incorporating the recommendations of the MPHD. However, NPC commissioned a project during the early phase of this plan to prepare a long term Agriculture Perspective Plan (APP), which recognized citrus and apple as high value commodities. The APP (1997-2017) is now at its final phase of implementation. All the programs envisioned in the APP for fruit development were reflected in the 9th and 10th plans. Similarly, the three consecutive three year interim plans (2007/08 onwards) were also supportive for fruit development. Apple Self-Reliance Program, Lime Mission Program and Citrus Rejuvenation Program have been implemented in these periods. In recent years, many private orchards have been established in many parts of the country. There are many visible pocket areas of major fruit crops, such as banana, mandarin orange, junar, and apple, and their value chain maps have also been developed for some districts. However, to ensure fair share of the domestic market; maintain competitiveness with the imported fruits; and ultimately to aim at exporting fruits to foreign markets, greater technological advancement is required in both production and post-production programs.

Recently the government has approved Agriculture Development Strategy (ADS) on 12 June 2015. ADS expects to guide agricultural sector for the next 20 years. Though the document mentions that horticulture has larger role to play, and points out increasing trend of deficit of trade due to import of fruits, ADS does not prioritize fruit development activities . Fruit is not even listed in top 15 value chain ranking. Fruit is just addressed in ADS as a commodity in special support to overall rural communities' livelihood across Nepal.

CONSTRAINTS TO FRUIT DEVELOPMENT

Fruit development in Nepal is constrained with a number of factors which can be broadly categorized as (1) input supply and production constraints; and (2) postharvest management and marketing constraints.

1. Input supply and production constraints:
    - Weak linkage between input suppliers and fruit producers.
    - Inadequate numbers of agrovets or other input suppliers in fruit production areas.
    - Existing suppliers have limited technical knowledge and outreach..
    - Nursery/orchard owners not aware of the varieties, pollinizers, and package of practices.
    - Inadequate credit support to the entrepreneurs and input suppliers.
    - Inadequate training to the nurserymen and other input suppliers.
    - Lack of road access in most of the production areas.
    - Poor market information service.
    - Poor nursery management practices and disease and insect-pest management.
    - Unavailability of improved varieties of rootstocks.
    - Difficult to identify mother plants of desired varieties.
    - Unavailability of nursery equipment.
    - High initial investment for orchard establishment.
    - Weak monitoring and follow-up support from the service providers.
    - Small and scattered land holding.
    - Long gestation period of the crop.
    - High risks due to natural calamities and lack of supportive insurance policy.
2. Postharvest management and marketing constraints
    - Inadequate knowledge and skill of the farmers on handlings of fresh fruits.
    - Inadequate packing facilities and high cost of packing materials.
    - Short harvesting period.
    - Inadequate support in processing industries.

- Inadequate storage facilities.
- Information on production, market demand and consumers' preferences lacking.
- Value chain not adequate and transparent.
- Poor road connectivity.
- Weak linkage between market functionaries.
- Inadequate marketing infrastructures.
- Higher marketing cost due to mainly high transportation cost.
- Poor road conditions and disturbances in transportation.
- Long time taken for transportation to consumer's markets.

WAY-FORWARD

- Significant change cannot be expected without research back stopping. Government should give priority to fruit research program.
- Without enhancing the capacity of technical units(Directorate, Program, Farm, Laboratory including quarantine etc) and their manpower, drastic change in fruit development cannot be achieved; so they should bestrengthened to tackle the technical issues of fruit farming.
- Government should focus the development of commercial pocket areas of fruit farming by developing road access including gravity rope ways in hilly areas where feasible, small irrigation, rural electrification and collection centers at strategic locations which will create an enabling environment to attract the fruit growers as well as private sectors investment on commercial fruit farming.
- Market/demand oriented commercial fruit production plan should be tied up with full package of activities including micro-finance, technical support, and insurance etc. Trading business man/company should be linked to the fruit grower's groups/cooperatives. Group marketing should be encouraged. Fruit processing industries should also be linked to the production groups/cooperatives.
- Provision of direct government support on up scaling of commercial fruit orchards and export market of fruit should be made. Initiative should be taken for establishment of cold chain system for exportable fruits of the country.

- Quality aspects in fruit saplings production and distribution; fruit production, postharvest and marketing should also be prioritized. Nursery Act should be formalized. Nepal Standards/Voluntary standards of fresh fruits should be developed and should be brought into practice.
- Private sectors should be encouraged to establish resource centers for fee based inputs supply as well as technical supports to the fruit growers related to fruit farming.
- Specialized manpower (fruit tree based horticulturists, plant protection officers and soil scientists) should be developed and their technical support should be made within the access of commercial growers.
- Social mobilization part should also be taken into consideration while developing commercial production plan.This aspect should be done through LNGOs/CBOs with government support.
- Fruit database and documentation should also be initiated at fruit growers level and provision of extra incentive package should be made for such type of fruit growers.

CONCLUSION

Despite the suitable climate and expanding market for fresh fruits and processed products, the growth of fruit industry has remained slow in the last six decades. Work on fruit research is inadequate and extension program is very general. NGOs and other development partners are least interested in fruit development as most of the fruit crops take long time to give returns or results. Furthermore, long gestation period of the crops, high initial cost for orchard establishment, and high risks due to mainly lack of reliable weather forecasting system and marketing are discouraging farmers for growing fruit crops. However, most of the fruit crops are environment friendly and some of these crops can be successfully grown even in undulating landscapes and the lands with earthquake-induced cracks. In fact, the adoption of fruit cultivation results in more efficient use of scarce land resources in the country like Nepal. Moreover, fruit trees contribute to carbon sequestration, as are done by forest trees. However, a thorough planning of programs on research and development is required for growth of fruit industry in Nepal. Fruit industry in Nepal cannot be expanded unless small farmers and entrepreneurs are supported by the government.

REFERENCES

ADS, 2015. Agriculture Development Strategy, Ministry of Agricultural Development. (Approved by the House Committee on 12, June 2015, Singh Durbar, Kathmandu..

FDD, 2014. Annual Progress Report of 2013/2014. Fruit Development Directorate/Department of Agriculture, Kirtipur, Kathmandu.

FDD, 2008. Annual Progress Report of 2006/2007. Fruit Development Directorate/Department of Agriculture, Kirtipur, Kathmandu.

HDP, 1995. Proceedings of the Seminar on Fruit Development in Nepal held during 22-24 February at Kirtipur. Horticulture Development Project, Kirtipur, Kathmandu.

ICAR, 2001. Hand Book of Horticulture. Indian Council of Agricultural Research, New Delhi.

Kaini, B. R., 1999. The wild relatives of fruit crops in Nepal. In the Proceedings of the National Conference on Wild Relatives of Cultivated Plants in Nepal published by the Green Energy Mission, Nepal, PP129-136, Kathmandu.

Kaini, B.R., 2013. Package of practices for Junar Production and Post-harvest Management, JCCU and JICA-Nepal, Kathmandu..

MOA, 1990. Master Plan for Horticulture Development. Ministry of Agriculture Government of Nepal, Kathmandu.

MOAC, 2014. Statistical Information on Nepalese Agriculture. Ministry of Agricultures and cooperatives, Government of Nepal, Kathmandu.

MOF, 2013. Economic Survey of the Fiscal Year 2011/12 Ministry of Finance/Government of Nepal, Kathmanud.

NARC, 2004. Advances in Horticultural Research in Nepal. Proceeding of the Fourth National Workshop on Horticulture. Nepal Agriculture Research Council, Khumaltar, Lalitpur.NAST, NARC and NHS, 2009. Proceedings of the Fifth National Seminar on Horticulture. Nepal Academy of Science and Technology, Nepal Agriculture

Research Council and Nepal Horticulture Society, Kathmandu..

NCDP, 2014. Annual Progress Report of 2013/2014. National Citrus Development Program, Kirtipur, Kathmandu.

Nepali, S.B. 2001. Salient features of horticulture sector in the APP. Proceedings of the Second National Horticulture Workshop, pp 55-59. Nepal horticulture Society, Kirtipur, Kathmandu.

NPC, 1995.The Agriculture Perspective Plan. National Planning Commission/Government of Nepal, Kathmandu.

Shrestha, G.P. and G.K.Shrestha, 1999. An overview of fruit growing in Nepal. Nepalese Horticulture, Vol.3, Issue 1, pp 36-40, Nepal Horticulture Society, Kirtipur, Kathmandu.

Shrestha, G. K., 1998. Fruit Development in Nepal. Publisher: Technica Concern, G.P.O. Box 3602, Kathmandu.

Shrestha, P.P. 1993. Fruit Production, Research and Development in Nepal. In Research and Development of Fruits in the Pacific Region edited by R.B.Singh and published by RAPA, Bangkok, Thailand.

VEGETABLE DEVELOPMNENT IN THE LAST SIX DECADES IN NEPAL

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ABSTRACT

Domestication and cultivation of vegetables has always been the integral part of agriculture in Nepal since time immemorial. However, the official effort of vegetable research and development could be traced back to mid19th century when Rana Prime Minister Jung Bahadur Rana introduced European vegetables in Kathmandu valley. Then, another Rana Prime Minister Chandra Samsher established Agricultural Council in 1937 and gave due importance in agricultural research including vegetables. Establishment of experimental and plant introduction farms in Kathmandu valley, Kakani and Parwanipur and seed sale store in New Road, Kathmanduwere the initial works. Vegetable research and development took some momentum during 1940 to 1972. However, this sub-sector geared up only after 1972 when agro-eco-zonal strategies were adopted in vegetable research and its fresh and seed production. Nepal celebrated Agriculture Year(1975/76) with two strategies: 1) Commercial/market oriented fresh vegetable production in accessible areas and along the road corridors, and 2) Vegetable seed production in the remote areas. From 1980 onward different donor funded projects contributed in vegetable research, seed and market oriented fresh production. By 1995 some 35 vegetable varieties were released. Seed Entrepreneurs' Association of Nepal (SEAN) was established. Area, production, productivity and per capita availability and consumption of vegetables have increased. During recent time, import of hybrid varieties is in increasing trend replacing Nepalese open pollinated varieties. Government of Nepal has prepared and approved Seed Vision 2013-2025 to increase the varietal replacement rate to 90 % and release additional 30 hybrid varieties (20 by public and 10 by private sector) to increase productivity, meet commercialization target and increase competitiveness of Nepalese vegetable sector.

BACKGROUND

Vegetables in ancient Nepal

Nepal lies between two large civilizations:Aryans in the south and Mongols in the north. During ancient timescow herders (Gopalbansi) came to Nepal valley (present Kathmandu) from the Ganges Plains of modern-day India, and sheep herders came from Tibet and inhabited in northern Nepal. The history of Nepal has been influenced by its position in the Himalayas and its two neighbors, Indiaand China. Due to the arrival of different settler groups from outside through the ages, Nepal is now a multi-ethnic, multi-cultural, multi-religious and multi-lingual country. Gopalbansi, Mahisapalaka, Lichchhavi, Kirats, Thakuris, Malla and Shah ruled Nepal since ages (History of Nepal Wikipedia, 2015). All those rulers contributed to shape Nepal in the present state. Nepal's physiographic and agro-ecological setting, due to altitudinal variation and multi-sphere facings, favor for different ethno-biodiversities. The Indo-Aryans from the south and Mongols from the north settled in different altitudes as per their suitability to their climatic requirements. Thus, Nepal is the land of Aarya-Mongol civilization with hybrid cultures. Whosoever came to this part of the earth also brought plant materials including vegetables with them. Thus, domestication and cultivation of different vegetables as integral part of civilization and agricultural system goes back to the era when present Nepal was scattered in many local states and royal units. Whatsoever local states and royal units existed, subsistence agriculture was the means of livelihood. The study of ancient writings and archeological evidences show that vegetables were as an integral part of agriculture and civilizationsince more than 2000 years.

The British Empire in India and unification of Nepal in 18th century by Prithvi Narayan Shah had impact on vegetable diversities in Nepal. Modernization of agriculture in India started during British regime showed impact in Nepal as well. Unofficial entrance of some seeds of vegetables to Nepal through pilgrimage and ex-army returnees from India also enriched vegetable diversities in Nepal. However, the recorded reports of some exotic vegetable cultivation in the manorial gardens of Rana ,the then de-facto rulers of Nepal, could be traced back to mid 19th century when the then Nepal's Rana Prime Minister Mr. Jung Bahadur Rana and his dignitaries received the European vegetable seeds as gift during his visit to the United Kingdom and Europe. Slowly these vegetable seeds leached out to the local farmers of Kathmandu valley through the gardeners of Rana palaces and the cultivation of temperate vegetables such as cauliflower, cabbage, onion, turnip etc. became popular in Kathmandu valley. Along with these crops indigenous vegetables like broad leaf mustard (Rayo), Pyuthane radish, pumpkin, gourds, colocasia, yam, cowpeas, beans, etc. were cultivated for family use and for the local markets of Kathmandu (Verma, 1994).

Nepal's Vegetable Bio-diversity

Nepal is the land of wonder with her agro-climatic variability. Almost all types of world climate and a wide range of bio-diversity exist in Nepal. Leaving aside the vast number of micro-flora, the larger plants group alone is believed to be existing at more than seven thousand species (Hara et al., 1978). In case of food plants 172 families, 296 genera, 599 species and 35 sub-species are found in the country. Out of 599 species of food plants 400 species belong to horticultural groups of which 200 species are vegetable crops (Regmi, 1982). Among 200 species of vegetables around 50 species are in cultivation (Pandey, 1994a).

Nicoli Ivanovich Vavilov, a Russian scientist,had conducted his study from 1916 to 1936 and established main eight centers of origin of crop plants. Among eight centers, Nepal is surrounded by five centers of origin: i) Chinese center of origin, ii) Indo-Burmese center of origin, iii)Central Asian center of origin, iv) Asia minor center of origin and; v) The Mediterranean center of origin. Nepal lies in Indo-Burmese center of origin and believed that *Dioscorea alata, Lactuca sativa, Luffa acutangula, Momordica charantia, Solanum melongena, Trigonella foenum, Trichosanthes anguina, Brassica rapa, Cucumis sativus, Cucurbita moschata, Phaseolus vulgaris* etc. were found in wild state andbelieved to be originated from this center of origin.

Official start of vegetable development in Nepal (1937-1950)

After Jung Bahadur Rana who contributed in vegetable development in Rana's manorial garden, Chandra SamsherJBR1 established Agricultural Council as the first government entity for agricultural development in 1937. The council opened agricultural farms in Kathmandu valley in Tahachal and Balaju. At present Tahachal is used for some other purposes and Balaju Nursery converted to Modern Park. Government initiated research and development in vegetable sector since 1940 with

1 JBR is Jang Bahadur Rana ,title given to Ranas as successor

the testing of some exotic and indigenous vegetables in the Central Experimental Farms at Tahachal and Balaju Nursery in Kathmandu since 1942. In these farms seeds of different vegetable varieties such as tomatoes and cabbage were produced. To promote sales of the vegetable seeds thus produced, government opened vegetable seed store during 1942 in New Road near Taleju temple to make the seeds available to the general farmers. In Balaju nursery cabbage seed production was successfully done in 1946 (old record of Agriculture Council). During 1948 first agricultural farm outside Kathmandu valley was established in Parwanipur, Baraas multi crop research station where vegetable research for tropical region was one of the important activities. During 1937 to 1948 vegetable production increased intensively in Kathmandu valley and some special pockets of hills and Terai.

The First Department of Agriculture (1951-1965)

Rana regime ended in February 1951 and new democratic era started in Nepal. The Agriculture Council established in 1937 was converted to the Department of Agriculture in 1952 with Horticulture Section within it and to look after the development of fruits, vegetables and flowers. Horticulture section established two plant introduction units 1) Putali Bagaicha, Singh Durbar and 2) Plant Introduction Unit, Godavari to introduce exotic vegetables and fruits and study their adaptability. During 1952 the first Horticultural farm was established in Kakani to study fruits, vegetables and flowers. United State's Oversea Mission in 1952 and Mountaineering Troops from Japan in 1953 had been the two principle formal sources to import exotic vegetable varieties.Japanese Troop gifted some vegetable seeds of Radish, Carrot, and Turnip etc. to the government and White Neck variety of radish was commercialized in and around Kakani areas of Nepal. Horticultural Section, after studies and trailsduring 1952-1956, recommended some new vegetable varieties for general cultivation and seeds were made available to common people from seed store at Basantpur, New road, Kathmandu.

Initiation of planned development

Nepal started planned development from 1955/56when the first five year plan (FYP) was implemented with high priority to agriculture for better and efficient use of resources. Donors like USAID and Indian

Cooperation Mission supported agriculture including horticulture. Since 1956/57 a new program "Tribhuwan Gram Bikash (Tribhuwan Rural Development)" was initiated with block development approach. Block Development Officers (BDOs) and Gram Sewaks and Sewikas (Village Development Workers) were posted at village level for rural awareness and development. This was an integrated community development model including agriculture, health and sanitation, adult education, home science and agriculture. This program introduced different vegetables in rural Nepal with people's participation. Youth clubs, 4-H clubs, cottage industries, etc. were the components of this program.

During second FYP (1960/61-1964/65), government opened different agriculture/horticulture farms /stations in the different agro-ecological zones of Nepal.During this plan period horticulture units were opened in agriculture farm/stations of Terai. New horticulture farms were opened in Daman/Makawanpur, Dhunibeshi/Dhading and Baitadi with the help of Indian Cooperation Mission (ICM). In the vicinities of these farms/stations, vegetable production were demonstrated and extended. Mainly home gardening was emphasized which slowly developed to produce vegetable for the local markets and haat bazzar. In Terai new agriculture farms were opened in Nepalgunj,Bhairahawa, Janakpur, and Terahara and also in the hills horticultural farm/stations were established in Dhankuta, Kirtipur/Kathmandu, Trishuli/Nuwakot, Pokhara/Kaski and Bhagedada/Doti. These farm/ stations were mandated to test, multiply and sale /distribute the horticultural planting materials (fruit saplings and vegetables seeds).By the end of this plan total horticultural farm stations reached 14. District Agriculture Development Offices (DADOs) were established for agriculture extension and development. In the center horticulture section was under the Department of Agriculture (DoA). The programs of horticulture in the farm/ stations were controlled by horticulture section of DoA. During this plan Rehabilitation Company established new settlements in Terai especially in Chitwan and Doon valleys. Rampur Agriculture Station and Yagyapuri Horticulture Farm were established (the latter is now handed over to Cancer Hospital). All these farm/centers and rehabilitation program promoted vegetable production for home consumption and local sale.

Department of Horticulture (1967- 1972)

The third FYP (1965/66- 69/70) was the turning point in the horticultural development in Nepal. To provide due priorities to different sectors and commodities the Department of Agriculture was reorganized in 1966/67 to 5 different departments (Department of Agriculture Education and Research, Department of Agriculture Extension, Department of Livestock Development, Department of Horticulture and Department of Fisheries). Department of Horticulture was housed in Kirtipur with two major sections viz. Fruit Development Section and Vegetable Development Section. Kirtipur was the main center of research and development for fruits, vegetables, potato and flowers. Horticulture farms of different agro-eco-zones were under the Department of Horticulture (DoH). Vegetable research, seed production and seed sale used to be done by these horticultural farms and some seed were sold from Basantpur seed store as well. District Agriculture Development Offices also purchased vegetable seed from horticulture farms/ stations and Basantapur seed store as there were no other private and government outlets for vegetable seed.

During 1967 to 1970, the Department of Horticulture (DoH) established additional horticultural farms/station in Humla, Jumla, Dolpa, Mustang, Rasuwa, Helambu/Sindhupalchowk, Boch/Dolakha, Panchkhal/Kavre and Nawalpur/Sarlahi to push the horticulture development and the number of horticulture farms reached 23. All these farm/centers contributed in vegetable research, seed production and fresh vegetable production in their command areas and served as the growth centers for fruits and vegetables development.

Unified Department of Agriculture (1972-1990)

During the 4th FYP (1970/71-1974/75) the concept of regional development was adopted. Five departments were united to one single Department of Agriculture (DoA). Under the DoA sub-sector development approach was realized in horticulture sector. Accordingly, Fruit Development Division (FDD), Vegetable Development Division (VDD), National citrus Development Program (NCDP) and National Potato Development Program (NPDP) were established. During this plan period 6 new farms viz. Vegetable Seed Production Center Khumaltar, Vegetable Seed Production Center Rukum, Horticulture Farm Sindhuli, Nucleus Potato Center Nigale/ Sindhupalckok, and Cardamom Development Farm Fikkal/ Ilam were also established. Establishment of VDD and Vegetable Seed Production Center Khumaltar during 1972 was the milestone in vegetable research and development. VDD started functioning with clear mandate of research and development since 1975 adopting the eco-zonal based strategy for vegetable research, vegetable seed production and fresh vegetable production.

Agro-ecological approach for vegetable development

During the 5th FYP (1975/76 -1979/80) Nepal adopted agro-eco-zonal based approach in vegetable development. In Nepal, there are three broader distinct agro-ecological zones viz. Terai/plain, mid hills and high hills with some specific zones in trans-Himalayan region. Within these zones specific micro-climatic situations and special pockets exist due to variation in altitude, slopes, facings, surrounding hills and valleys. Nepal being situated in northern hemisphere in temperate zone, there is four distinct seasons in a year such as spring, summer, autumn and winter. Due to high agro-biodiversity of vegetables, more than 50 kinds of vegetable crops are commercially grown in Nepal. To fit into these agro-ecological zones and micro-climatic pockets for each region and season, at least four sets of adaptable vegetable varieties under each kind of crops and their seed availability is the ideal requirements for the year round supply of a particular kind of vegetable. Thus, it involves two tiers of research viz. fresh vegetable production and seed production. Considering four varieties of each of fifty crops to be developed with fresh and seed production techniques the task appeared to be Herculean. To cope with above task, VDD since 1975 adopted the eco-regional approach for vegetable research and seed production with the following four major strategies:

- Introductions of exotic germplasm; and collection, evaluation and selection of indigenous land races and development of high yielding vegetable varieties suitable for different agro-ecological regions and seasons
- Generation of improved and appropriate crop husbandry, plant protection and seed production techniques for improved varieties

- Commercial/market oriented fresh vegetable production demonstration in accessible areas and along road corridors and
- Technology generation for vegetable seed production in the remote areas where fresh vegetable marketing is difficult.

According to the above strategies, five major centers for vegetable research and farmer's field vegetable seed production zones were adopted. Vegetable Seed Production Center Khumaltar, Horticulture Farm Sarlahi, Agriculture Station Dhankuta and Horticulture Farm Mustang and Vegetable Seed Production Center Rukum were identified as the five major centers for research. Under the technical guidance of these Farm/centers contract seed production of major vegetable varieties were started in Bhaktapur, Nuwakot, Sarlahi, Dhankuta, Tehrathum, Bhojpur, Mustang,Rukum and Salyan. Agriculture Input Corporation (AIC) was given the responsibility of vegetable seed marketing by 1975. Seed buying contract used to be done by AIC and foundation/source seed supply and field supervision by VDD. During 1981 Vegetable Seed Production Center was established in Dadeldhura to expand vegetable seed production and fresh vegetable production along the road corridors of Far Western Development Region.

Donor support in vegetable development

With the beginning of the 6th FYP (1980/81) to gear up the research and development in vegetables, supports from different donors were initiated.

Fresh Vegetable and Vegetable Seed Production Project: This project was funded by the Swiss government through FAO as a Technical Cooperation Project from 1980/81 to 1994/1995 (6th to 8th FYP) and worked in three phases as the counter part of VDD. This project further strengthened the approach initiated by VDD during fifth five year plan and continued till eighth five year plan. The commendable impacts of this period were as under:

Variety development, maintenance and seed production

Seven Farm/Centers as center of excellence for vegetable research, variety development and breeders and foundation seed production were recognized as presented in Table 1.

Table 1: Farm/Centers selected for vegetable research and variety development

S. No	Name of Center	Altitude (M)	Micro-climate	Priority crops for research
1	Horticulture Farm Dhankuta	1200-1400	High rainfall, high humidity	Radish, Mid season Cauliflower, Broad Leaf Mustard, Pea, Cress, Spinach etc,
2	Horticulture Farm Sarlahi	100	High rainfall, high humidity, hot summer, mild winter	Early Cauliflower, Radish, all Solanacious and Cucurbitaceous crops, Beans, Cowpeas
3	Vegetable Seed Production Center Khumaltar	1350	High rainfall, high humidity, frosty winter	Radish, Cauliflower, Broad Leaf Mustard, Beans, Swiss Chard, Cress, Spinach, Turnip, Tomato, Eggplant, Onion, Chili, Capsicum
4	Horticulture Farm Mustang	2522	Low rainfall, snow in winter, low humidity, mild summer	Late Cauliflower, Cabbage, Carrot, Broad leaf Mustard (Marpha), Late Radish
5	Horticulture Farm Dolpa	2242	Low rainfall, snow in winter, low humidity, mild summer	Late Cauliflower, Cabbage, Carrot, Broad leaf Mustard (Marpha), Late Radish
6	Vegetable Seed Production Center Rukum	1440-1500	Mild rainfall, high humidity, warm summer, chilly winter	Radish, Mid season Cauliflower, Broad Leaf Mustard, Beans, Cress, Spinach, Turnip, Tomato, Eggplant, Sweet pepper, Onion, Peas, Carrot, Squash
7	Vegetable Seed Production Center Dadeldhura	1400	Mild rainfall, high humidity, warm summer, chilly winter	Radish, Mid season Cauliflower, Broad Leaf Mustard, Beans, Cress, Spinach, Turnip, Tomato, Eggplant, Sweet pepper, Onion, Peas, Squash

Besides above seven farms, two British aided farms viz. Lumle Agricultural Center (LAC) and Pakhribas Agricultural Center (PAC) also were linked and coordinated for vegetable research, development and seed production.

Variety development

During 15 years of FAO project support VDD established sound footings for research in different selected farms/centers (first phase of FAO 1980-83). During the second phase (1984-87) the project continued to support for variety evaluation and also developed a sound base for variety maintenance, and the production of breeders/nucleus and foundation seed. Prior to 1980/81, 25 vegetable varieties were already popular among farmers and organized seed production was in place. However, with the project support, new stock seeds were imported to replace deteriorated seed stock. During 1981-91 the project supported the evaluation of 350 new germplasms of different vegetables collected from exotic and indigenous sources and selected 47 superior varieties. Including already popular 25 varieties and new varieties developed, 72 varieties were identified by 1991 and based on these research results, 35 vegetable varieties were released in 1995 and maintenance system was adopted.

However, when NARC was established in 2090/91 and new departmental reorganization was made, the horticultural farm/centers were divided between NARC and DoA. Consequently, vegetable research and variety maintenance were distorted. From 1995 to 2014 only five additional new varieties of vegetables were being officially released but without being linked to variety maintenance scheme and commercial seed production and marketing of those varieties. Thus variety development, maintenance and seed production of Nepalese varieties could not keep pace with market demand and vegetable seed import is increasing.

Variety maintenance

Based on the mode of pollination and breeding behavior of recommended vegetable varieties, the variety maintenance program and methods were developed by VDD and the project during the 6th FYP. To ease the variety maintenance work, varietal (morphological) characteristics of identified varieties with their marked genetic trait, maintenance methods, and technical procedures for each group of crops were developed and documented for the use and reference. A well defined variety maintenance techniques and system of one farm one variety was adopted. Until 1990, in various agro-ecological zones there were 33 horticultural farms under unified DoA including seven center of excellence for vegetable research and variety maintenance under one command of VDD and thus the maintenance was easy. A variety maintenance chart was developed denoting farm/centers and varieties to be maintained and produce breeders and foundation seed. To clarify the maintenance scheme, as for example cauliflower crop, variety Kathmandu was to be maintained by Khumatar, Rukum and Dhankuta, Snow Ball was to be maintained by Dolpa, Kibo Giant by Dadeldhura and Deepali by Sarlahi; and cabbage variety by Marpha. Similar arrangements were made with other cross pollinated crops as well. However, at present, this arrangement has become non-functional.

Seed production

A sustainable seed production chain consists of three sequential stages: (1) Variety maintenance and breeder's seed production, (2) Foundation/source seed production, and (3) Certified /truthful labeled/ improvedseed production. Responsibility for stage 1 rests with the breeders who are independent professionals or associated with an agency. Seed production chain from variety development, its maintenance, breeders and foundation seed production and commercial seed production for good quality seed distribution is of prime importance. VDD and the project adopted the systems and procedures to maintain seed chain. Each farm/ center was made responsible to produce quality breeders and foundation seed linking to the farmer's field commercial seed production. During 5th to 7th plan period, VDD was the sole coordinator of vegetable and vegetable seed production.

Agriculture Inputs Corporation (AIC) in vegetable seed marketing

Till 1974 vegetable seed production and distribution were the responsibility of government farms only. Agriculture Inputs Corporation (AIC) was mandated for vegetable seed marketing from 1974. Due to the increasing demand of high quality seed, contract seed production in farmer's field in different agro-ecological zones was started from 1975. AIC used to make contract agreement for vegetable seed purchase with the farmers as recommended by VDD. Foundation seed and technical supervisions used to be provided by VDD along with the designated farm/centers of the production zones. VDD used to organize breeders and foundation seed production and made available to AIC for improved contract seed production. For the safety, 100 % of breeder's seed and 50 % of foundation seed requirements were used to be kept as buffer stock.

Private sector in vegetable seed marketing

During 1970 one private seed shop was opened in Asan Tole, Kathmandu in the name of Annapurna Beej Bhandar (By Prem Lal Shrestha) which was the first vegetable seed shop in private sector in Kathmandu valley and started selling both local and imported vegetable seeds. There were a few vegetable seed traders in major cities outside Kathmandu valley. Slowly the seed entrepreneurs in Kathmandu valley and main cities of Nepal such as Bhadrapur, Birtamod, Biratgagar, Janakpur, Birgunj, Butawal, Pokhara, Nepalgunj, Dhangadhi and Kanchanpur were also opened. VDD/FAO facilitated to establish Seed Entrepreneur's Association Nepal (SEAN) in 1989 and registered in 1991 as an umbrella organization of seed entrepreneurs with 32 members which now has more than 300 members spread over 37 districts and seed dealing entrepreneurs are more than 2000 and handles more than 90 % vegetable seed trade. These private sector seed entrepreneurs started contract seed production with the support from different donors to meet the demand. However, to meet the increasing demand of quality seed, especially hybrid seeds, imports have also increased during recent decades (SEAN, 2013). The numbers of imported and registered vegetable varieties by entrepreneurs have reached to 20 OPs and 231hybrids (SQCC, 2010).

ADDITIONAL DONOR SUPPORT IN VEGETABLE SEED PRODUCTION

Along with VDD/FAO fresh vegetable and vegetable seed production project, chronologically the donor support in vegetable seed production and fresh vegetable development can be summarized as follows:

- **Japan International Cooperation Agency (JICA)** supported VDD from 1983 -87 to develop new varieties and modern technology in fresh vegetable production and seed production. This project introduced protected cultivation of tomato and sweet pepper in half opened plastic tunnel in Khumaltar with proven success. With passage of time this technology was further replicated by different projects, I/NGOs and have been established as an important off-season production technology by now.
- **Regional Vegetable Research Project-RAS/89/04** Connected with Fresh Vegetable and Vegetable Seed Project, FAO Regional Vegetable Research Project-RAS/89/041 also contributed in germplasm exchange among Asian countries like China, Korea, Thailand and SAARC countries during 1987 to 1988.
- **South Asia Vegetable Network (SAVERNET)**, from 1991-1993, introduced different varieties of vegetables for adaptive test. However, conclusive results could not be obtained due to administrative anomalies among researchers.
- **Vegetable, Fruits and Cash Crops Development Project, (VFC/Rapti),** from 1984-1990, was successful to scale up seed production and marketing by many folds in Rapti zone through No Frills Consultancy. However, due to its negligence in providing quality foundation seed and quality control services, it lost Nepalese radish seed market in Bangladesh. This project failed to collaborate with research and seed chain maintenance.
- **Koshi Hills Seed and Vegetable Project (KOSEVEG)**, from 1992-1997, was designed to develop an effective, sustainable and market oriented seed and vegetable program for increasing food production and household income. The social mobilization process of the project was notably a successful feature and the creation of local farmers' association was particularly important. It supported in forming KOSEPAN and linked the seed growers with national and regional seed traders for sustainability even after the project phased out.
- **Community Based Economic Development Project (CBED)** from 1997-2002. CIDA funded CBED adopted the demand based

vegetable seed production program linking seed growers with seed traders through regional seed contracting workshops. It was successful in introducing the seed production practice in the far western hill districts of Nepal.

- **Market Access for Rural Development (MARD)** from 1997-2002. USAID funded MARD Project supported farmers groups and cooperatives for vegetable seed production and its marketing in Surkhet, Dailekh and Nuwakot districts. Due to poor linkage with GoN line agencies the impact could not last long.
- **Seed Sector Support Project (SSSP)**, from 1998- 2003, was a successor of the KOSEVEG project and adopted the same approach for seed production and marketing. The approach was based on contractual seed production agreed by seed producer groups and seed buyers during seed planning workshops. The model was later replicated in other districts (Dadeldhura and Achham). SSSP contributed in enhancing the seed industry of Nepal and is also particularly known for private seed sector growth. It supported processing equipments and laboratory establishment of SEAN Seed Service Center (SSSC) at Thankot. It is a well equipped company owned by more than 50 SEAN members.
- **Participatory Vegetable Seed Project (PVSP)**, from 2001-2003 and funded by DANIDA, was the first vegetable seed production project implemented by NGO viz. Center for Environmental and Agricultural Policy Research, Extension and Development (CEAPRED) in six districts of Nepal including both hill and Terai district.
- **Vegetable Seed Project (VSP),** from 2004-2014 funded by Swiss Agency for Development and Cooperation (SDC), was implemented by CEAPRED in order to benefit poor farmers in remote areas by diversifying their income opportunities through vegetable seed production and marketing. Main contributions of this project included:
    - Synergistic approach of combining seed production in the remote districts and fresh vegetable in road corridors with focus on poor, women and disadvantaged households for

increased income and food security.

- Institutionalizing farmers' groups into seed cooperatives and linking them with entrepreneurs through Pre-contract Marketing Agreement
- Seed Producers' Central Co-operative Federation Ltd. registered as umbrella organization of primary seed cooperatives that facilitate for demand based production and nationwide marketing of seeds linking with seed entrepreneurs of all over the country for sustainability
- **Internal Quality Control (IQC)** has been established for quality assurance at production level and this needs formalization by DADO and SQCC

- **Other Projects** Apart from those aforementioned, there were other programs or parts of different projects of small initiatives in different aspects of seed. Some organizations are still continuing small support to these initiatives (e.g. NARDF, PACT, IWRMP, HIMALI, JICA etc). At present High Value Agriculture Project and Kishanko Lagi Biu Program, implemented by government, are working in the field of seed production and management.

As cumulative results of all these efforts the increase in vegetable seed production in farmer's field and government farms from 1975 till 2015 is presented in Table 2.

Table 2: Vegetable seed production trend and domestic requirement from 1975 to 2015

Year	Government sector	Private sector (farmer's field)	Total production	Total equirement	Gap	Gap %
1975/76	9	1	10	293	283	97
1979/80	12	8	20	343	322	94
1984/85	12	21	33	770	737	96
1989/90	15	190	205	775	570	76
1994/95	11	250	261	855	594	69
1999/00	12	430	442	1310	868	66
2004/05	11	810	821	1569	748	48
2009/10	8	930	938	1840	902	49
2014/15	8	1050	1058	1920	862	45

Source: MoAD (2014) and CEAPRED (2015).

Despite the multifold increment of seed production in Nepal (10 MT in 1975 to 1050 in 2014/15), many seed traders have been importing different kind of seeds from different countries due to shortage of seeds of modern high yielding varieties and specially hybrid seeds in the domestic market. Commercial fresh vegetable growers prefer to use imported hybrid seeds.The projected demand of vegetable seed for the fiscal year 2009/10 was 1840MT which increased to 1920 in 2014/15. The estimated domestic production remained only about 930 MT in 2009/10, a shortfall by almost half of the demand (CEAPRED, 2010). Rest of the demand is met either by farmer-to-farmer exchange of often sub-standard seeds or by import of open pollinated and hybrid seeds. Most of the vegetable seeds produced in Nepal are of OP varieties whereas in some of the crops like cabbage, cauliflower and tomato, the largest part of growth in seed demand is for hybrids (CEAPRED, 2010). Nepal has released only one hybrid tomato variety Srijana and production is not in line with the demand.

IMPORT AND EXPORT OF SEEDS IN NEPAL

Flow of vegetable seed from India has been a common practice since long due to open boarder. It has always been difficult to assess the amount of seed import from India. Therefore, one of the objectives of vegetable development in the sixth and seventh plan (1980-90) was to substitute the import of vegetable seed promoting domestic production. The domestic seed production of OP varieties increased from 10 Mt in 1975 to 1050 MT in 2014. However, a study carried out by CEAPRED in 2010 and SEAN in 2013 showed that many Nepalese OP varieties are being rapidly replaced by imported OPs and hybrids. The increasing trend of vegetable seed import is presented in table 3.

Table 3: Trend of vegetable seed import in Nepal

Year	Total Seed import (MT)	Hybrids (MT)
2002/03	213	12 (6%)
2008/09	680	48 (7%)
2012/13	969	512 (52%)

This trend is expected to continue in future as well.

Vegetable seed export from Nepal

Vegetable seed export to Bangaldesh was initiated by AIC in 1987/88. Later SEAN members started export of radish seed to Bangladesh and its steady development is presented in table 4.

Table 4: Vegetable seed export from Nepal

Year	Quantity MT	Major vegetables	Countries
1087/88	0.5	Radish	Bangladesh
1988/89	9.8	Radish, Eggplant, Cauliflower	Bangladesh/India
1989/90	20.0	Radish, Tomato Eggplant, Cauliflower	Bangladesh/Germany/ India/Japan
1990/91	16.2	Radish, Tomato Eggplant, Cauliflower	Bangladesh/Germany/India
1991/92	14.5	Radish	Bangladesh/Germany/India
1992/93	11.2	Radish	Bangladesh/Germany/India
1993/94	23.7	Radish	Bangladesh/Germany/India
1998/99*	45	Different Vegetable seed	Bangladesh/Germany/India
1999/00*	124	Different Vegetable seed	India
2000/01	30	Different Vegetable seed	India
2001/02	71	Different Vegetable seed	India
2011/12	89	Different Vegetable seed	India

Source: SEAN (2013)

During 1999/00 vegetable seed export from Nepal reached to 124 MT which then declined to 89 MT in 2011/12. There are several factors causing decline in the export of seed from Nepal. The major reasons were low quality and higher price of Nepalese seed. For example, farm gate price of Mino Early variety of Radish costs around Rs.210 per kg in Nepal whereas the seed imported from New Zealand costs around Rs.180 per Kg in Bangladesh.

FRESH VEGETABLE PRODUCTION AND MARKETING

Jyapu in the Kathmandu valley and Koiris in the Terai were the two peasant communities who have specialized in commercial vegetable production and marketing before planned agriculture development started from public sector i.e. government. Before the start of modern agriculture development in Nepal, Kathmandu valley had sustainable organic vegetable production practices (Pandey, 1994 c and NHPC, 2004). Their marketing strategies were to take their produce door to door and at special cross roads and sell individually. Sometimes, they used to go beyond valley to barter or exchange vegetables with cereals. Some of them also sold to local retailers in Kathmandu valley.

With the establishment of Tribhuwan Gram Bikash and latter establishment of Agriculture/Horticulture farm/centers vegetable production demonstration started outside Kathmandu valley near district head quarters and market settlement. Slowly market oriented production of vegetables started to take pace. Horticultural farm/centers and DADOs started promoting home gardening and market oriented production through demonstrations. With beginning of sixth five year plan fresh vegetable production program was classified into two major programs

General/home Gardening Production Program

General program was for home consumption.Mainly kitchen/ home garden packets of vegetable seeds used to be made available to the farmers. It was mainly for nutritional improvement. DADOs used to conduct kitchen garden demonstration for its promotion with different types of vegetables for balanced diet and year round production.

UNICEF, ADB and VDD jointly distributed vegetable seed composite packets (one lakh packets per year) through DADOs from 1981to1989. Latter this model was adopted by different organizations such as Women Development Program, and other community organizations working in the field of health and nutrition.

Market Oriented/special Production Program

The market oriented production program was implemented along the road corridors. Major road corridors selected at the beginning were mainly Daman-Palung corridors of Tribhuwan high way, Dhunibesi-Mugling and Mugling-Pokhara of Prithvi high way, Pokhara-Bhairahawa corridors of Siddhartha high way and Kathmandu-Trishuli road corridors for fresh vegetable supply to Kathmandu valley and other major cities. Market oriented production demonstrations were carried out jointly by VDD and respective DADOs with intensive training and inputs support to the farmers along East-West high way, near district head quarters and in the vicinity of other market centers.

Technical support from The People's Republic of China was made available through FAO to expedite the market oriented production of fresh vegetable through vegetable seed campaign to promote the use of Nepal produced high quality seed during 1983 to 1985. This campaign conducted trainings and supplied production inputs through DADOs to conduct production demonstrations and farmer's field days. The campaign during its three year time conducted 400 demonstrations in five major road corridors and 9 district head quarters. At the end of three years seed campaign, fresh vegetable production outreach was included as the regular commercial and kitchen gardening program of DADOs in the districts.

During 1985 to 1990, low height plastic tunnel for early growth of cucurbitaceous crops along Naubise- Charaundi road corridor was demonstrated in large number by VDD/FAO project and GTZ project through DADO Dhading which have now become popular for early vegetable production to catch the niche market.

Establishment of Fruits and Vegetables Markets

Till 1973 vegetable production in the country was very small. The practice of shipment of vegetables from one production center to distant urban consumer center was virtually non-existent till 1975. Kathmandu valley used to be self sufficient in vegetables as the population of valley was less and vegetable production areas were huge. The vegetable marketing system was characterized by rudimentary stage of development. However, the efforts of the farms/stations and DADOs increased fresh vegetable production and unorganized markets started to grow in different parts of the country. Realizing the need of organized markets for vegetable marketing, Department of Food and Agricultural Marketing Services (DFAMS) was established in 1973. The first step in vegetable marketing was the establishment of Ranamukteshwor Fruits and Vegetables Retail Market Center in Kathmandu in 1975.

In the mid1980s, it was realized that the supply of vegetables from different production centers to Kathmandu valley must efficiently be channelized to meet demand of the capital city. In this context, the then DFAMS initiated the program of establishing and developing a Fruit and Vegetable Wholesale Market at Kalimati in Kathmandu. Establishment of Kalimati Fruit and Vegetable Whole Market (KWM) was initiated by acquiring 2.05 ha land as central market in 1987. The prospective plans and design was prepared by DFAMS. With the continuous effort of Fresh Vegetable and Vegetable Seed Production Project, the United Nations Capital Development fund (UNCDF) provided grant assistance of US$ 4.6 million for basic construction of KWM and was completed by 1995. The transaction of vegetables in KWM increased from 42,273 MT in 1992/93 to 189,346 MT in 2014/15 (ABP and MDD, 2014).

After the success of KWM, different wholesale markets emerged up in different parts of Nepal. Agricultural Wholesale Market Birtamod, Jhapa was constructed for food grain trading in 1979 by UNDP/FAO. Later it spontaneously emerged as a satellite wholesale market of KWM and also developed as vegetable and fruit market. The Hill Fruit Development Project (HFDP) provided additional facilities to cater some of the needs of vegetable marketing. In addition to Birtamod, HFDP also supported wholesale market development in Dharan, Basantpur and

Katari/Udaipur.

In addition to KWM in Kathmandu, the UNCDF also supported construction of three vegetable marketing sheds in Lalbandi, Sarlahi. Similarly, UNCDF funded Small Marketing Infrastructure Development Project supported construction of more than 20 collection centers in different parts of Nepal where vegetable production were increasing. These small market infrastructures are functioning even today at different nodes of East-West highway and niche points of hills and other cities of Nepal.

Kapurkot market in Salyan was another turning point for fresh vegetable marketing in the hills of mid-western region. It used to supply vegetables to different markets of Nepal and also export to India. Secondary Crops Development Project also contributed in developing wholesale markets in mid and far western region where fresh vegetable marketing was growing and taking pace fastly.

The area, production and productivity of fresh vegetable increased from 1975/76 to 2014/15 steadily (table 5).

Table 5: Area, Production and productivity of fresh vegetables from 1975/76 to 2014/15

Year	Area ha	Production MT	Productivity MT/ha
1975/76	82,000	410,000	5.00
1979/80	96,000	528,000	5.50
1984/85	138,200	743,000	5.38
1989/90	140,524	967,167	6.88
1991/92	140,500	1,227,884	8.03
1995/96	144,368	1,327,298	9.20
2000/01	157,162	1652,979	10.50
2004/05	180,823	2,065,193	11.40
2009/10	235,098	3,003,821	12.70
2014/15	245,000	3,629,000	14.80*

Source: VDD, 2014/15; * Projected for 2014/15.

During 1975/76 the area under vegetable was estimated to be 82,000 ha with production of 410,000 MT and conservative productivity of 5.00MT/ha.In 2009/10, the area increased to 235,098 ha with the production of 3,003,821 MT and average yield of 12.77 MT/ha. The projected production for 2014/15 is 3,629,000 MT from an area of 245,000 ha with an average yield of 14.8 MT /ha. (VDD, 2014)

Nepal with a wide range of agro-ecological variation creates a comparative advantage for the production of different vegetable crops. The production of seasonal and off-season vegetables, utilizing these ecological niches, has been extremely beneficial in the context of nutrition, employment, and income generation. The Nepal government is also emphasizing the production of offseason vegetables in the hills of Nepal as an important cash crop that could enhance the income level of farmers and thus help reduce the incidence of poverty (APP, 1995). Due to the higher return per unit of land, the area, production, and productivity of vegetables are increasing day by day.

Off-season Vegetable Production in Nepal

During late sixties Horticulture Research Station, Kirtipur initiated tomato cultivation in Dhunibesi/ Dhading to meet the demand of tomato in Kathmandu during winter. It did work due to warm climatic condition of most part of Dhading along the highway. Similar experiences of solanacious vegetables cultivation in Terai plains brought positive outputs. During seventies, cultivation of cauliflower and cabbages during summer in high hills and mountains were also successfully demonstrated by VDD, LAC and PAC in different regions. Based on these successes and experiences the terminology of"Off-season vegetable" was included in Agriculture Perspective Plan (APP, 1995).

In general term, off-season vegetable farming refers to the production of vegetables before or after their normal season of production. However, in the present context it is wider and beyond the normal terminology. Off-season productions now a days are accomplished by using different agro climatic conditions, adjusting the planting time, selecting and improving the varieties, and/or creating controlled environments (by making plastic tunnels, polythene houses, permanent glasshouses, etc.). Mostly off-season vegetable is defined in relation to consumption or demand of the centers of destination market. For production areas it is normal season production, but for demanded destination market it is off-season commodity. Examples are as

- Tomato, chili, eggplant, beans are the winter vegetables of the Terai plains and are off-season commodity for high hill regions.
- Cabbage, cauliflower, carrot, broad leaf mustard, radish, etc. are winter vegetables by nature but these are produced in high hills during summer rainy season as normal production but are off-season commodity for mid hills, lower hills and plain areas.

Utilizing the agro-climatic comparative advantages both hills and Terai produce vegetables for off-season markets. During 1960 to 1990 the sole contributors in the development of fresh vegetable production and marketing included Ministry of Agriculture, DoA/VDD, farm/stations under it and aid supported projects like PAC and LAC and different Integrated Rural Development Projects. The most important project that supported DoA/VDD is the HMG/FAO vegetable and vegetable seed production project which coordinated all three sub-sectors of vegetable development viz. vegetable seed production, fresh vegetable production and vegetable marketing infrastructure development from 1981 to 1995.

During later 25 years from 1990 to 2015 the players and contributors in vegetable sector included both public and private sectors. New horizon opened after restoration of democracy in 1990. Different I/NGO appeared as main players in fresh vegetable production. CEAPRED was the first norm setter for fresh vegetable commercialization along north south road corridor such as Dharan-Dhankuta and Arniko highway. Many other areas such as Panchkhal (Kabhre), Tistuing, Palung and Daman (Makwanpur); Ranipauwa (Nuwakot); Basantpur, Hile and Sidhuwa (Dhankuta); Madanpokhara (Palpa), north south road corridors of Dadeldhura, Ratanangla/Dailekh and Kapurkot/ Salyan are some of the examples for off-season production and are expanding each year due to the potential of off-season marketing. Currently, Bangladesh and northern border-side markets of India hold the greatest potential for Nepalese off-season produces. Over the last decade, the attraction of off-season vegetable production has increased.For income generation and poverty reduction fresh vegetable production in accessible areas and vegetable seed production in the remote areas have become the proven strategies.

FUTURE PROSPECTS AND WAY FORWARD

Fresh vegetables play very important role in nutrition security, food security, income generation and livelihood improvement. Increased production and productivity of vegetables depends on high quality seed including hybrids. Lessons learned from successes and pitfalls have resulted in shaping the future prospect and way forward. As we move along the path of progress, several opportunities will appear and these needs to be utilized for the benefit of wider farm families.

Variety development

A large proportion of improved seeds particularly hybrids in vegetables are being imported, particularly from Japan, India, Thailand, Korea and China. Nepal must collect, evaluate and develop pest resistance and stress tolerance varieties from local germplasms for climate resilience. In order to reduce the import of hybrids, NARC should have Hybrid Research Unit (HRU) under National Commodity Programs and Divisions with adequate funds and human resources as envisaged in Seed Vision, 2025.It is envisaged that 30 hybrids comprising 20 by public sector and 10 by private sector would be developed and released to increase vegetable production and productivity as well as seed replacement rate from 68 to 90 % by 2025. Furthermore, different classes of vegetable seed production have also been quantified as presented in table 6.

Table 6: Status of 2010 and projection of different classes of seed by 2025

S. No	Classes of seed	Projected requirement (MT)			
		2010	2015	2020	2025
1	Breeder's seed	0.55	0.878	0.955	1.204
2	Foundation seed	22	35.12	38.18	48.14
3	Certified/labelled/ improved (OP) seed	1,100	1,756	1,909	2,407
4	Hybrid seed	30	40	70	90
	Total	1,152.6	1,832	2,018.2	2,546.4

Source: SQCC, 2012.

To achieve the goal set (Table 6), emphases on variety development must be given utmost priority.

Variety maintenance

Variety maintenance is an important component of quality source seed production. Maintenance of crop varieties in their original ecological domain is essential to produce quality source seed and retain original genetic vigour and unique characteristics of the varieties. However, currently, there is a limited use and compliance of zoning concept in maintenance of varieties. Variety maintenance chart for vegetables prepared during eighties by VDD and recently revised by NSB has to be implemented based on agro ecological zones, domains of the research centres and farms. Original genetic vigour and unique characteristics of some of the vegetable varieties have been published by CEAPRED, 2014. Present status of breeder seed production and its projection in Seed Vision is discussed in seed multiplication section since breeder seed is an output of the variety development chain, which is also an input for the seed multiplication chain (SQCC, 2013).

International and national linkages and collaboration

At present, the linkage and collaboration of national commodity programs with international institutions and private R and D organizations is limited. Except for major food crops (rice, maize, wheat, legume and potato), virtually there are no linkages and international support for developing new varieties in vegetables. Development and strengthening link is essential for increased germplasm exchange and sharing of information and technology. Similarly, linkage of domestic plant breeding programs with national gene bank is weak. As a result, flow of new germplasm, modern technological information and the use of locally diverse genetic resources available are limited. It is suggested that gene bank operational guidelines need to be developed and implemented with special reference to vegetable crops. Research collaboration and partnership among NARC, AFU, DoA and NARDF needs reorientation and working towards national goal of hybrid variety development in vegetable crops. Researches of M. Sc. and Ph. D. students and faculty members must be linked with National Seed Vision, and National Agricultural Research and Development Fund (NARDF) should play supportive role.

Linkages with international institutions and Universities, and joint ventures for new variety development and hybrid seed production should be given high priority by both government and private sector.

CONCLUSION

Vegetable is a complex sub-sector as it has to address a wide variety of vegetable species and cultivars and develop varieties suitable to varying agro-ecological environments. Thus, research inputs from both public and private sector (Seed companies, non-governmental organizations and farmer's research) are very crucial to meet the target set in Seed Vision and Agriculture Development Strategy (ADS). Considering the fact that there has been rapid replacement of OP varieties by hybrids, the need for research has crucially emerged for identification of indigenous cultivars and demonstrating their commercial value, developing new OP varieties and parental lines for hybrid variety development. Public sector research could be led by NARC in collaboration with Vegetable Development Directorate and University of Agriculture and Forestry. Private sector research could be done by private seed companies and NGOs in partnership with public sector in participation with farmers.

Production, consumption and marketing of fresh vegetables have been increasing during recent decades. Farmers are demandingimported hybrid vegetable varieties that are high yielding, short durational and suitable to different agro-ecological environment and different season. However, this should not be at the cost of Nepali OP varieties which possess immense potential in terms of farmer's acceptance, adaptability to local climatic stress and tolerance against several pests and diseases. Therefore, investment in farmer's preferred priority vegetable crop research for new OP varieties and parental lines development for hybrid seed production, and proper maintenance of released and registered varieties must be stream lined. Sustaining the seed value chain from breeder's (nucleus) seed to improved/labeled seed production is needed with proper quality assurance through truthful labeling under a collaborative action involving all related government, non-government, private and cooperative stakeholders. It is also necessaryto increase competitiveness of Nepali seeds both in domestic and international markets through quality assurance, branding and packaging.

Fresh vegetable production and marketing is always led by supply of good quality inputs, mainly seeds, and market management. Safe products with no or within the limit of pesticides and mainly hazardous pesticide free products are in demand. Clean, well branded, nicely packed and well displayed fresh vegetable products are in increased demand. Fresh vegetable market functions and trader's behavior should be changed to benefit both fresh vegetable producers and consumers with well planned production program, regular supply chain and heading towards international standards of fresh vegetable market development.

The comparative advantages both for vegetable seed production and fresh vegetable production have to be harnessed in all the ecological zones of Nepal for year round commercialization of fresh vegetable production. Vegetable seed production of temperate to tropical crops from Terai to high hill must be done with proper zoning of seed production. Hills and high hills are suitable for temperate vegetable seed production whereas Terai, inner Terai and low hill basins are suitable for solanacious, cucurbits, okra and legume seed production.

REFERENCES

APP, 1995. Agricultural Perspective Plan, National Planning Commission, His Majesty's Government of Nepal and Asian Development Bank. Agricultural Projects Services Center, Kathmandu and John Mellor Associates, Inc. Washington D.C.

Bhomi B., 1913. Some information about Horticulture Development in Nepal. A collection of book on "Horticulture Development in Nepal", pp 36-46. Nepal Horticulture Society, 2013.

CEAPRED, 2010 a. Final report of Marketing Survey of Vegetable Seed demand, production and import situation in Nepal. Center for Environmental and Agricultural Policy Research, Extension and Development.

CEAPRED, 2010 b. Project Document of Vegetable Seed Project

(2011 to 2014) submitted to SDC. Center for Environmental and Agricultural Policy Research, Extension and Development.

CEAPRED, 2015. Project Completion Report of VSP (2011 to 2014) submitted to Swiss Agency for Development and Cooperation (SDC). Center for Environmental and Agricultural Research Policy Research, Extension and Development. Ghale Y. and I.R. Pandey, 2009. Asia Brief:A status paper on "Vegetable seed to improve livelihood in rural Nepal". Published by South Asia Regional Office of SDC.

Hara H., W. T. Steam and J.H.J. William, 1978. An enumeration of the flowering plants of Nepal, Volumes 1-2.

History of Nepal Wikipedia, 2015. Google search from the free Encyclopedia.

ABP and MDD, 2014. Annual progress report of Kalimati Market. Agri-business Promotion and Marketing Development Division.

MoAD, 2014. Statistical Information Agriculture Year Book 2013/14. Ministry of Agriculture Development.

NHPC, 2004. What has made Jyapu Techniques of vegetable Farming Sustainable in Kathmandu Valley? An exploratory study of technology, economics, and management. Nepal Horticulture Promotion Center.

Nepali S.B.P., 2013. The Horticulture, pp. 11- 15. A collection of book on "Horticulture Development in Nepal" published by Nepal Horticulture Society, 2013.

Pandey I.R., 1994 (a). Status of vegetable genetic resources in Nepal, pp.112-118. In 'Proceedings of Workshop on Plant Genetic Resources on Nepalese Perspective in Nepal', organized by NARC and IPGRI, 28 Nov.-1 Dec, 1994, Kathmandu, Nepal.

Pandey I.R., 1994 (b). Wild relatives of cultivated plants in Nepal, pp. 121-128. In 'Proceedings of workshop on Wild relatives of cultivated plants in Nepal', organized by The Green Energy Mission /Nepal. June 2-4, 1999, Kathmandu, Nepal.

Pandey I.R., 1994 (c). Indigenous Methods of Sustainable Vegetable Production in the Kathmandu Valley, Nepal. In the booklet published byRegional Office for Asia and the Pacific (RAPA), FAO,

Bangkok, Thailand.
Pandey I.R., 2013. Chronological History of Vegetable Seed Production in Nepal, pp. 64- 86. In a collection of book on "Horticulture Development in Nepal" published by Nepal Horticulture Society, 2013.
Regmi P.P., 1982. An Introduction to Nepalese Food Plants, a book published by Royal Nepal Academy.
Rana D.S., 1995. Project Completion Report of 'HMG/FAO Fresh Vegetable and VegetableSeed Production Project'.
SQCC, 2010. A booklet on released and registered vegetable varieties for commercial cultivation in Nepal, Seed Quality Control Center.
SQCC, 2012. National Seed Vision, 2013 to 2025(Seed Sector Development Strategy), Seed Quality Control Center.
SEAN, 2013. Survey Report of Market Information Study for Analyzing National Demand, Supply and Import/export Situation of Vegetable Seeds in Nepal. Seed Entrepreneurs' Association, Nepal.
Verma S.K., 1994. HMG/FAO Fresh Vegetable and Vegetable Seed Production Project impact study report by Swastik Development and Consultant.
VDD/MoAD, 2014/15. Annual program and budget. Vegetable Development Directorate, Ministry of Agriculture Development.

FLORICULTURE IN NEPAL: A NEW AND VIBRANT SUB SECTOR OF HORTICULTURE

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ABSTRACT

Floriculture in Nepal began some seven decades ago by palace gardeners. However it developed in a more organized pattern only after formation of Floriculture Association of Nepal (FAN) in 1992. The growth of flower industry is quite satisfactory but the growth of different product and services is different. Some product and services such as seasonal flowers and seeds, ornamental plants and landscaping and gardening are growing more rapidly than other such as loose flowers and exports. This paper highlights significant effort made by private sector while the role of government agencies responsible for research, extension and teaching are not adequate. The approval of Floriculture Policy by government of Nepal in 2013 has paved way for more effective role of government agencies in collaboration with private sector. This collaboration shall largely be responsible for success in taking Nepalese floriculture to the next level.

INTRODUCTION

Floriculture in Nepal began some seven decades ago by palace gardeners but formal floriculture business began only in the early nineties of the last century (Pun, 1997). The formation of Floriculture Association of Nepal (FAN) in 1992 resulted in more organized business, data recording, introduction and multi location trial of new crops, setting up wholesale outlet of cut flowers and formation of floriculture cooperative. Two years back, FAN was successful in getting the government to approve Floriculture Policy in 2013and it was a huge achievement. The private sector was looking forward for the positive changes this policy shall bring to propel significant growth in the industry. As per the policy, FAN was to get financial support for five years and the first financial year has concluded. It is also equally important to look back at what different government agencies have done or are doing towards the development of floriculture in Nepal (Pun, 2014).

FLORICULTURE IN NEPAL AT A GLANCE

The status of floriculture in Nepal is very encouraging. The industry is steadily growing over the years and in 2015 the share of different products of floriculture are as shown below (Table 1). The total annual turnover reached new height of Rs. 127.75 crores (FAN, 2015) and this growth was possible due to rapid growth in some sub-sectors (e.g., ornamental plants).

Table 1: Floriculture Industry Data: overall 2013-14

S/No	Description	Amount (Rs in crores)
1	Seasonal Flowers and Seeds	21.68
2	Ornamental Plants	38.15
3	Cut flowers and foliage	20.45
4	Landscaping and gardening	17.04
5	Loose Flowers	6.70
6	Input Supplies (Silpouline, Planting Materials and Equipments)	12.40
7	Others (carpet grass, bulbs, rhizomes, tuber, tissue culture plantlets etc	8.33
8	EXPORT	3.00
9	TOTAL	127.75
10	IMPORT	4.00

Source: FAN, 2015

The growth of floriculture sector in last two decades has seen steady good. It began with annual turnover of Rs. 1.8 crores in 1994 to Rs. 127.75 crores in 2015 (Table 2).

Table: 2 Annual growth of floriculture industry in Nepal (crores)

Year	1993/94	2005/6	2008/9	2011/12	2013/14
Total Value	1.8	23.0	56.0	105.32	127.75

However, the growth of different product and services of floriculture is not similar. There are some products that are growing at a much faster rate than others (Table 3). The faster growing products may result into many new opportunities. The products that have made tremendous growth are seasonal flowers and seeds, ornamental plants, cut flowers and foliages, landscaping and gardening and input supplies.

Table 3: Fast growing sub-sectors of floriculture industry (Rs in crores)

S/No	Description	1993/94 (crores)	2005/06 (crores)	2008/09 (crores)	2011/12 (crores)	2013/14 (crores)
1	Seasonal Flowers and Seeds	0.30	2.5	6.0	16.56	21.68
2	Ornamental Plants	0.26	10.0	16.0	32.0	38.15
3	Cut flowers and foliage	0.22	2.0	3.5	16.0	20.45
4	Landscaping and gardening		2.5	10.0	12.0	17.04
5	Input Supplies (Silpouline, planting materials and equipment)		2.0	3.0	7.5	12.40

However in other sub-sectors such as loose flowers,growth is slower as compared to fast growing sub-sectors (Table 4). Similar is the situation of others such as carpet grass, bulbs, rhizomes etc. The situation of export is also very unstable with frequent increase or decrease of sales. However, import has been slowed down. The role of research and extension agencies of the government can work closely with private sector so as to improve product and make it more competitive.

Table 4: Slow growing sub-sector of floriculture industry (Rs in crores)

S/No	Description	1993/94 (crores)	2005/06 (crores)	2008/09 (crores)	2011/12 (crores)	2013/14 (crores)
1	Loose Flowers	0.32	2.0	3.0	4.5	6.7
2	Others (carpet grass, bulbs, rhizomes, tuber, tissue culture plantlets etc		2.0	5.0	5.80	8.33
3	EXPORT			6.0	10.96	3.0

INDUSTRY

Floriculture in Nepal is led by Floriculture Association of Nepal (FAN), a commodity association of Federation of Nepalese Chambers of Commerce and Industry (FNCCI) with an annual growth of 10-15% (Gaire, 2015). This is the representative of the industry and should be given full credit for the development of floriculture in Nepal. In the initial years, Agro Enterprises Center/FNCCI supported FAN with financial support from United States Agency for International Development (USAID). In last few years, FAN is working more closely with Ministry of Agriculture Development and finally after much effortwere put in for several years Floriculture Policy became a reality in 2013. This Policy shall be the guiding factor for development of floriculture industry in Nepal and shall be supporting Nepalese floriculture for five years with effect from year 2014-15 to 2018-19. This Policy has clearly spelt the role of all stakeholders; private sector, extension and research agencies of government. FAN had a lonely journey so far but with the government approving Floriculture Policy, the private sector is very excited and hopes the journey shall be more interesting and fruitful. The industry realistically needs support from government to graduate to the next level and the coming of the policy at this critical juncture is a clear indication that the government is totally committed for floriculture development in Nepal. In the first year (2014-15) of the funding (Rs. 10.0 million) from the government, major emphasis was put on system development at FAN, support for greenhouse system and documentation. In the second year

(2015-16) of funding (Rs. 55.0 million proposed), FAN has put major funding on upgrading greenhouse system which is critical to qualitative as well as quantitative production of cut flowers and ornamentals. It has also prioritized for export potential of a major filler crop in the cut flower industry. These are two products that are growing rapidly and could play critical role both on import substitution and export. The positive outcome of second year shall boost flower industry in a big way and there could be potential for export of cut flowers. Some of the most important cut flowers of Nepal are Carnation, Gladiolus, Gerbera, Rose etc. The participating private companies matched with 20% to the support given by government.

EXTENSION AGENCY

The department of agriculture (DOA), Harihar Bhawan, Lalitpur is the government agency responsible for technology dissemination of flowers production and marketing to farmers (Khatiwada and Shrestha, 2015). The DOA's Directorate of Fruits, Kirtipur, Kathmandu serves as the link between DOA and Floriculture Development Center (FDC) located at Godavari, Lalitpur. Besides, other DOA units such as Agribusiness Division or District Agriculture Development Office (DADO) also contribute towards floriculture development.

Floriculture Development Center: The government's focal agency for floriculture development is FDC. This was established in 2006 and is responsible for training farmers and also government staff. It also gives technical support to DADOs floriculture programs as and when required in addition to maintaining demonstration plots and conducting flower trials. It has also published booklets on ornamental plants of Nepal.

Agribusiness Promotion Program: This program has been supporting FAN for organizing floriculture expo annually in Kathmandu since 2006. In addition it also supports FAN to organize annual Chrysanthemum and Poinsettia shows. In 2007, it also published an extension booklet on Business plan for rose cut flower production.

District Agriculture Development Office: Although, flowers and ornamental plants are commercially produced in 38 districts yet many districts do not have any program for flower farmers. Recently, some urban districts are incorporating floriculture in their annual district program. In 2013, floriculture program was incorporated in four districts of central Nepal (Kathmandu, Bhaktapur, Kavare and Chitwan).

In addition to government agencies, several NGOs/INGOS were also involved in dissemination of floriculture technology in the community. Although, DOA is responsible for technology dissemination there are often cases where there is lack of subject matter specialist (SMS) in important flower production districts. Besides, there is lack of SMS for management of urban green spaces such as parks and gardens. This is the area where DOA needs to re think and consider up-gradation of FDC. Thereafter FDC should have dual role; training and technology dissemination of flower crops and ornamentals and management of urban green spaces such as parks and botanical gardens. Post-gorkha earth quake 2015, Nepal's urban planner are emphasizing on open spaces in the core city area across Nepal. However, there is acute shortage of trained human resource with regards to parks and botanical garden management.

RESEARCH AGENCY:

The Horticulture Research Division (HRD) of Nepal Agriculture Research Council (NARC) has been conducting floriculture research since late 1990s. There research is mainly in production technology of Gladiolus, Carnation, Marigold and Cymbidium (Khatiwada and Shrestha, 2015). Recently, Agriculture Research Station (ARS), Dailekh is conducting breeding research in Gladiolus. The number of research as well as funding is very low for floriculture. The funding in floriculture for five years beginning 2063-64 to 2068-69 BS is only 3.9 per cent and was for 8 projects only (Figure 1). This is very disappointing because there are many important issues that needs to be addressed but there seems to be communication gap between industry and research institution. Therefore it is important to have closer coordination between HRD and FAN for effective research support to the flower industry. In fact, HRD should have more frequent interaction with commodity association such as FAN to understand the research needs of commercial farmers.

Research efforts should be both for solving technical problems as well as for opening new opportunities to farmers and investors in floriculture

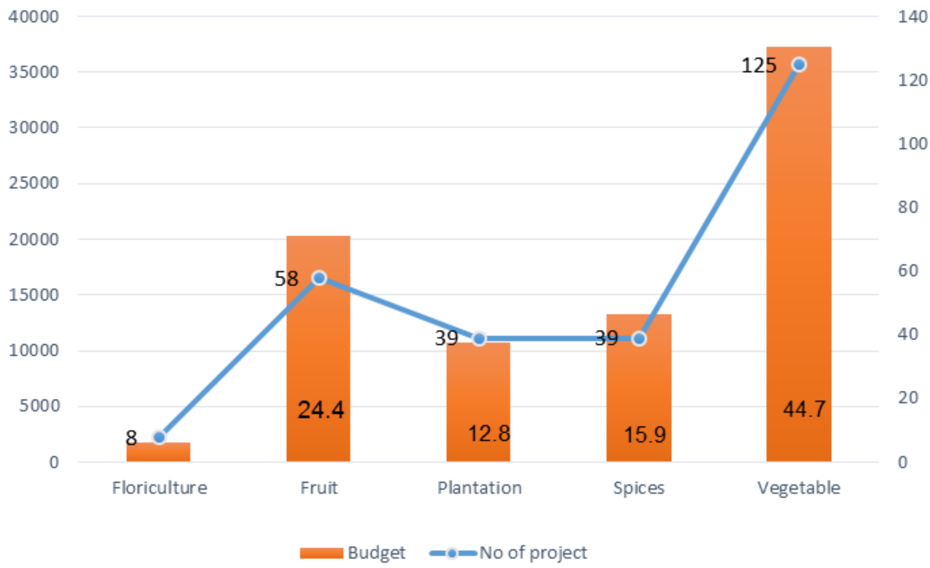

Figure 1: Funding of NARC in horticulture (f/y 2063/64-2068-69) (Rs in 000)

Source: Khatiwada and Shrestha, 2015

Prior to 2006, Department of Plant Resources (DPR) did several researches in floricultural crops. There research was mainly in micro propagation of several flowers such as orchids, carnation, rose, gladiolus etc. Flower industry lacks close coordination with DPR since last one decade but Floriculture Policy has provided space for DPR and FAN to collaborate. The role of DPR could be very instrumental in locating native ornamental plants, identifying them, and doing their botanical studies for registration. This joint effort between, industry people, botanist and horticulturist could bring a new ornamental plant from nature and even a new breed to the world.

EDUCATION AGENCY

The research of floriculture crops particularly production technology development began in Nepal from Institute of Agriculture and Animal Science (IAAS), Rampur during early 1990s. Research has been conducted in several flower crops such as Orchids, Gladiolus, Rose, Gerbera, Tuberose, Marigold and Carnation. This college has become Faculty of Agriculture, Agriculture and Forestry University (AFU) at Rampur. This university offers courses such as BSc (Ag), MSc (Ag) Horticulture and PhD in Horticulture. Besides, AFU is planning to offer MSc (Horticulture) Pomology/Olericulture/Floriculture/ Postharvest courses and BSc (Horticulture) in the near future (Baral, 2015). IAAS, Kirtipur offers courses in MSc (Ag) Horticulture and all the other colleges listed below offers BSc (Ag) with the exception of Mahendra Ratna Campus, Ilam that offers BSc in Horticulture and Floriculture Management. In addition to thesecolleges, there are several agriculture colleges where floriculture research is yet to begin. Some of the agriculture colleges of Nepal are as follows:

- IAAS, Paklihawa Campus, Tribhuvan University
- IAAS, Lamjung Campus, Tribhuvan University
- IAAS, Kirtipur Campus, Tribhuvan University
- Horticulture and Floriculture Program, Mahendra Ratna Campus, Ilam, Tribhuvan University
- Agriculture College, Baitadi, Tribhuvan University
- Agriculture College, Lamihe, Dang, Tribhuvan University
- Agriculture College, Tulsipur, Dang, Tribhuvan University
- Himalayan College of Agriculture Science and Technology, Kathmandu, Prubanchal University
- Nepal PolyTech, Bharatpur, Purbanchal University)

In addition to above, Junior Technical Assistant (JTA) and Junior Technician (JT) courses in Agriculture/Horticulture are conducted in several Technical Schools across the country. Recently School Board has developed many horticulture related courses that shall be offered as optional subjects for students of class 9 and 10 in the near future. The major focus is to make our young children trained in some vocation such as floriculture. This will impart in them some skill and help them get part time or full time job even while in school or college. In floriculture children would be exposed to plant nursery, cut flower production, florist and gardener and all these four areas have opportunities for job.

WAY FORWARD

The Floriculture Policy has clearly spelled the role of different stakeholders in this sector. It aims to put lots of resources for floriculture development in Nepal. The stakeholders need to play their part in achieving the common goal and should put the industry as the focal point. For example, mite problem in rose is a major issue, this problem need to be addressed by entomologist/horticulturist so that effective management system is put in place to mitigate this issue and farmer harvest quality rose flowers. Producing good quality roses would open up export opportunities and further bring more investment in the sector resulting in creation of more jobs and revenue. Effective implementation of this policy shall largely address the current communication gaps and hopefully make the system more effective. In some cases, the policy has to be more open so as to include larger participation. For example in case of research, while the policy states NARC and Agriculture and Forestry University, it should also be open to other agriculture colleges and universities so that floriculture research gets wider coverage. Floriculture in Nepal would prosper because during the recent annual general meeting (AGM) of FAN in 2015 the presences of its members was huge and were very excited. Cut flower production could see a big change in both quality and quantity in 2016.

REFERENCES

Baral, D. R. 2015. Role of agricultural university in development of floriculture industry in Nepal. Proceeding of workshop on floriculture development in Nepal: Prospects and Challenges 14-19

Gaire, L. N. 2015. Role of private sector in Development of floriculture industry in Nepal. Proceeding of workshop on floriculture development in Nepal: Prospects and Challenges 3-8

Khatiwada, P. and Shrestha, Y. H. 2015. Public sector involvement on Floriculture in Nepal. Proceeding of workshop on floriculture development in Nepal: Prospects and Challenges 9-13

Pun, U. K. 1997. Present status of floribusiness in Nepal. Nepalese

Horticulture. Vol 1, pp 40-45.

Pun, U. K. 2014. Two decades of floriculture journey in Nepal. Floriculture souvenir published during the 2nd International Flora Expo 2014 and Published by Floriculture Association of Nepal Vol 18, pp32 to 35.

Floriculture Association Nepal (FAN) 2015. Total business of floriculture in Nepal

HORTICULTURE RESEARCH IN THE LAST SIX DECADES

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ABSTRACT

Various government and non governmental organizations have continuously and consistently been engaged in horticultural researches although these organizations do not receive sufficient fundsfor this from the government. To prepare this paper, the results of the horticultural researches carried out by the faculties and students in academic institutes including TU/IAAS and AFU as well as NARC and DoA which were published in more than 32 volumes of IAAS journals (1977 to 2012), IAAS Research Reports (1982 to 2000), thesis of the post graduate students of Horticulture Departments at TU and AFU (2000-2015), IAAS Research Advances (Vol I and II, 2007), AFU Research reports (In press), Nepal Agriculture Research Journal published jointly by Nepal AgriculturalResearch Council (NARC) and Society of AgriculturalScientists Nepal (SAS-N) have been reviewed. Besides, informal discussions were held with several researchers/faculties of AFU and IAAS/TU and NARC while preparing this paper. Findings of the major researches/experiments relevant to horticultural based enterpriseson various fruits, vegetables, ornamental crops have been presented in this paper. Considering the human and laboratory resources at different institutes, collaborative researches should be conducted after setting priorities in the market/industria-oriented horticultural researches in the country.

HISTORICAL BACKGROUND OF HORTICULTURAL RESEARCH

Nepal is known as the country of sages, hermits and saints. Fruits and vegetables were used to be the essential parts of their ashrams. This shows that fruits were grown in Nepal since thousands of years ago. Horticultural crops were grown mainly for family consumption. Mango in Terai and mandarin orange in hills of Nepal are being grown from very old time. Bonavia (1890) and Tanaka (1929) found mandarin orange growing in semi wild condition and confirmed it as native of Nepal. In Mugu district 30 years old seedling apple tree was found near Rara Lake above Topla village (Shah, 1975). An interesting text of 60-70 years old history of horticulture is quoted in a book named*Udyan* (Horticulture) written by Ganga Bikram Sijapati and published in 2018 B.S. According to it "following the path of His Majesty the King Ran Bahadur Shah", for the first time, large scale orchards were established by the then Army Generals and Prime ministers. Six Hajminia Darbar (Rautahat District), Mirchaia orchard (Siraha) and mandarin orchard in Ilam were established. The credit for starting scientific fruit cultivation in Kapan and Ichangu goes to the priest Shri 6 Gururaj Hem Raj and Captain Shri Samsher Narshingh Rana. For this, plants of Apple, Peach, Plum, Persimmon, Cherry, Mandarin, and Sweet orange were brought from Europe, Japan, India, and other countries. The credit for bringing such unique fruits and creating attraction and interest in Nepal goes to the first agriculture graduate captain Dibya Bahadur Basnet. The credit also goes to the Indian fruit expert H. C. D. Pal who came to Nepal in 1999 A.D. for the guidance and directions for commercial fruit growing as well as his Assistant Mr. Satyalal Ranjitkar with B.Sc. Ag. Hort. (Sijapati, 1961; Shah and Basnet, 1983).

Above mentioned efforts paved the path to plantintroduction and researches on horticultural crops. During the same period Central experimental farm at Chhauni (Kathmandu), Godavari Darbar Orchard and fruit nursery at Balaju were established. Balaju nursery started producing saplings of Kashmiri pear, Peaches, Plums, Apple (Delicious Group) and Persimmon (Chojo and Hachia var.).

In Shrawan 2002 BS, Agriculture Development Plan was passed with Khadga Nisana and 20 years Agriculture Development Plan was also estimated to study about various fruits.

Hill Nursery at Kakani and Plant Introduction Farm atGodavari were established in 2008/09 BS. By B.S. 2012, several Horticulture farms began to be established by the aid of foreign Governments. Agri. Station Rampur (Chitwan), Parwanipur (Bara) (in B.S. 2004) and Tarahara (Sunsari) (in B.S.2017) were established by the U.S. Govt. During the same period (B.S. 2013-17) under village Development

Program, fruit plants were distributed to various parts of Nepal under the aid of Indian Government (Anonymous, 1961; Sijapati, 1961). After the termination of this programme, a Horticulture plan was prepared under the aid of Indian Government to establish Horticulture farms (trial orchards and nurseries) in various parts of Nepal with the main objective of planned Horticulture Development in the country. From B.S. 2017 to 2033, 24 Horticulture farms were established in tropical, sub-tropical and temperate zones of the country including trial orchards, nurseries (Kakani, Daman, Helambu, etc), Horticulture Research Station (Kirtipur), Citrus Research Station (Dhankuta) and Citrus Research Sub-station at Pokhara(Anonymous, 1961).

In the early stage of Horticulture Development (B.S. 2008-09 and 2016 -32), there was huge lack of experience, technicians, survey and data about various fruits in the country. Plantation was done on the basis of rough estimation of climatic condition. Farms were established for the study, research and plant production as well as to provide technical support and services to the farmers. Plants of temperate fruits used to be carried by air and distributed to the farmers of remote areas like Jumla, Humla, Mustang, Mugu, Dolpa, Manang, etc. About 15 years of experiences and information (results) showed that only altitude and temperature were not enough for successful fruit growing but other components of climate like time and quantity of rain, humidity and hail storm as well as soil conditionswere also needed to be considered and studied.The results also showed that Daman, Helambu, Kakani and Kathmandu were not suitable for commercial apple growing. Lower part and Pokhara valley and such areas were not found to be suitable for mandarin growing. Based on these results, plantation programmes were revised, and zones and areas were demarcated for various fruits.

VARIETAL TRAILS OF FRUIT CROPS IN THE EARLY PAST

A. At Kirtipur Fruit Research Station

- Peach and plums (6 varieties of each) were laid out and planted in B. S. 2018 (1963 A. D.)
- More than 75 varieties of apple were planted to study varietal performance as well as plant production.

- Mandarin and sweet oranges were planted for adaptability study.
- Several varietal and manurial trials were conducted at Kirtipur station.

Results of these trials, experiments and studies are not available. Citrus plants died within a year due to heavy frost (up to -2^0 C). Meteorological data used to be sent to Radio Nepal every morning from Kirtipur station. Some of the studies were not complete. Consequently, results were neither published (even as annual report) nor kept as record mainly due to unstable government and policy, quick transfer of officials, lack of dedication and system of record keeping, etc. Later, the results of vegetable researches were found to be published.

B. Study on Lapsi (*Spondias axillaris*)

The study on Lapsi was started in 2031B.S. as the demand of Lapsi fruit was very high especially for its preservation and candy making. To meet the demand was a big challenge as the Lapsi trees take about 10 years to come into bearing. Another big problem was that male and female trees were separate and was not possible to identify it before flowering. Plant propagation by inarching method was successful but it was time consuming and complex. T- budding, chip budding and tongue grafting were used for 2 seasons. Chip budding and tongue grafting gave good results. These two methods were continued to use for large scale female plant production (Shah, 2033/34 BS).

C. Citrus Research Station Dhankuta and Sub-station Pokhara

Under the Indian aid programme many varieties of sweet oranges were brought from India and planted at these two stations including local mandarins. The study was disrupted and not continued.

HORTICULTURE RESEARCH FROM NATIONAL AGRICULTURAL RESEARCH SYSTEMS

Upon realizing the need of a dedicated research entity within the government system, National Agriculture Research and Service Centre (NARSC) was created in 1987 to pursue overall agricultural research in the country. The centre had direct command on central level divisions and farms working on research and production (resource centres). Aiming to establish an autonomous research institution, Nepal Agricultural Research Council (NARC) was formed under an Act in 1991 upon abolishing the NARSC (NARC Vision from internet). The separation of service and research functions within the ministry had simultaneously divided its assets like central laboratories, research farms and human resources. Despite having the role and responsibilities of national agricultural research system, NARC could not get all the agricultural research facilities administrated by NARSC. Along with the high ranking officers, relatively well established and equipped research division/ centres remained within Department of Agriculture, whose primary responsibility was extension. More precisely, none of the horticultural research farms situated in and around Kathmandu Valley were handed over to NARC. Two central divisions viz. Vegetable Development Division based at Khumaltar and Fruit Development Division based at Kirtipur remained under the Department of Agriculture while restricting horticulture of NARC in a room of the administrative building in the name of Horticulture Research Division (HRD). The division only embarked its own field research activities after four years (in 1994) of NARC establishment. The technical gap for four years created a vacuum which hindered the smooth handing over of previous research undertakings. Its repercussions are still evident. HRD is believed to be the coordinating body for horticulture research within NARC. Paradoxically, it does not have any administrative and/or technical commands to other NARC entities involved in horticultural research.

Not only the technical leadership, horticulture research also faced problem on physical facilities in different agro-ecological domains and scientific staff. For example, NARC does not have dedicated multi-commodity horticultural research centres in the Central region to represent the hills and none for the far-west. Likewise, there is no research farm for high altitude horticultural research except one in Jumla. Poor agro-ecological coverage has lessened the use and appropriateness of the technology in the context of having different micro-climates in different part of the country. With regards to human resources, extremely few cross-cutting scientists are intensively involved in the research on horticultural crops because of extremely limited opportunities for international exposure. Only three (two CGIAR and one international centre) international institutions are working on horticultural crop but their involvement in Nepal is bare minimum except of International Potato Centre. Since NARC has adopted project based funding, higher number of projects are needed to absorb more budget. Because of less interest of cross-cutting scientists, budget absorption by horticulture is less incomparison with other sectors of agriculture. Analysis of six year (f/y 2063/64 – 2068/69) budget allocation in NARC revealed that only 12.12 to 15.42% budget was shared by horticulture (Paudyal and Khatiwada, 2015). Even with the limited investment and cross technical leadership for horticulture research in the national agriculture system, it has contributed to the advancement of technologies primarily for the benefit of semi/commercial farmers.

Paudyal and Khatiwada (2015) reported that 44.7% budget was absorbed by vegetable research which was followed by fruits (24.4%), spices crops (15.9%), plantation crops (12.8%) and floriculture (2.1%). While analyzing the discipline-wise resource allocation, they found the highest investment on breeding (41.9%) followed by husbandry (31.1%), plant protection (21.4%), postharvest (4.9%) and socio-economics (0.7%). The investment made on horticulture sector has yielded the tangible output. Listing down all the outputs in details would be beyond the scope of this paper, thus major achievements are highlighted hereafter. The efforts paid in breedingbrought forth 54 (51 open pollinated and 3 hybrid) released/registered varieties of vegetables and two fruit varieties. Two hybrids and many more open pollinated varieties are in pipeline for release and/or registration. The process of varieties registration on fruits and plantation crops is slow and potato is taking lead among the vegetable crops. Newly introduced citrus varieties, spur type apple and kiwifruits started bearing and NARC will be able to recommend new fruit varieties in near future. One each of ginger and turmeric varieties has been released in the case of spices crops.

Quantification of husbandry technologies is not straightforward because of not having any formal mechanism of technology registration.

However, there are many technologies which have really attracted the farmers. Plastic house technology is becoming boon to the farmers residing in peri-urban areas. Different models of plastic houses and mitigation strategies for second generation problem of plastic house farming are in the hand. Production season expansion through capitalizing varietal traits, altering husbandry practices, protective cultivation and modifying harvesting techniques is recommended on cauliflower, cabbage, tomato, radish, broadleaf mustard, carrot, bean, onion and chill. Likewise, varietal planning and growing zone alteration have made possible to expand citrus production season by additional four months. Nutrient management and irrigation studies were primarily concentrated on vegetables. Organic soil and pest management technologies have been more focused on tea and coffee along with vegetable crops. Disease insect management technologies are recommended for important pest of major fruits and vegetable crops like club root of cole crops, late blight management of potato, miley bug of mango etc. Coffee pulper, ginger washer and potato digger are popular mechanization technologies among the commercial farmers. Conventional propagation technique for difficult to asexual propagation species like macadamia nut and micro-propagation protocol for large cardamom along with improved seed germination techniques are being popular among the users. Postharvest loss reduction through improving handling and packaging are recommended on tomato, chilli, cauliflower and apple. Protocols for juice and wine preparation have already been recommended. Value chain studies on off-season vegetables, large cardamom, orthodox tea, organic coffee have already been made and intervened as appropriate.Horticulture Development Project under Department of Agriculture has recommended technologies for citrus, pear, persimmon and chestnut. The abstracts with full details of the indicated technologies could be referred from Paudyal and Subba (2012) and annual reports of NARC (2013, 2014 and 2015).

Regardless of continuous technological recommendations by NARC, the current level of technology generation is not meeting the expectation of the users. Horticultural enterprises becoming the first choice for foreign employment returnees they have been demanding advanced technologies than that of NARC's recommending. Floriculture is coming up very aggressively for import substitution and export promotion. Unfortunately, NARC is not even able to establish a strong unit for its research. Herbal and aromatic plants are also the component of horticulture but it is not in the screen of NARC's research. Not only meeting the client need, the policy directives given to public sector organization is also becoming a challenge to NARC. The target given by Seed Vision, 2013 is going to be extremely difficult to achieve considering the current pace of varietal development. It should also be noted that National Agriculture Research and Development Fund, another organization under Ministry of Agriculture Development, is also involved in horticultural technologies generations through funding basis.

HORTICULTURE RESEARCH FROM ACADEMIC INSTITUTIONS

Agriculture educational institutes like Agriculture and Forestry University (AFU), Tribhuvan University /Institute of Agriculture and Agriculture Science (IAAS) and other private organizations as well as Department of Agriculture have been involved in the research related to the major horticultural problems and issues relevant to our country. Since the inception of Directorate of Research and Publication (DOR) under Dean's Office at IAAS in 1989, this separate wing has been engaged to motivate the faculty as well as students to seek fund from different national and international organizations to conduct research projects and also to publish research findings. Similarly, Directorate of Research and Extension, AFU is functional for the research on different crops including horticultural crops. In different academic institutes, horticultural crops are the 2nd major crops after agronomical crops in which various researches covering various thematic areas have been carried out.

Several on-station as well as on-farm experiments were carried out in various thematic areas of horticultural crops including varietal evaluation, soil fertility management, seed production, nursery/ propagation techniques, flowering, fruiting as well as growth, quality and yield of fruit, use of plant growth regulators, insectpest and disease management, post harvest management, etc. In horticultural sector, researches were conducted in more than 21 vegetable crops, more than 8 fruit crops and more than 4 ornamental crops. Among vegetable species, the major vegetables in which researches were carried out are onion, okra, broccoli, cauliflower, potato, carrot, tomato, chilli and sweet pepper. The major aspects in which researches were accomplished are nutritional management, cultivation practices, cultivar/genotype performance, post harvest life, plant growth regulator and off season production in descending order of magnitude. With respect to fruit and plantation crops, major species in which researches were conducted are mandarin, banana, litchi, lime and guava and major researchable aspects are post harvest quality maintenance, propagation, PGR application, quality improvement, cultivar characterization and off season production. Similarly, gladiolus, marigold, rose, tuberose, carnation and gerbera are major ornamental species in which researches were carried out mostly in the aspects of post harvest quality maintenance, management practices, nutritional and PGR application.

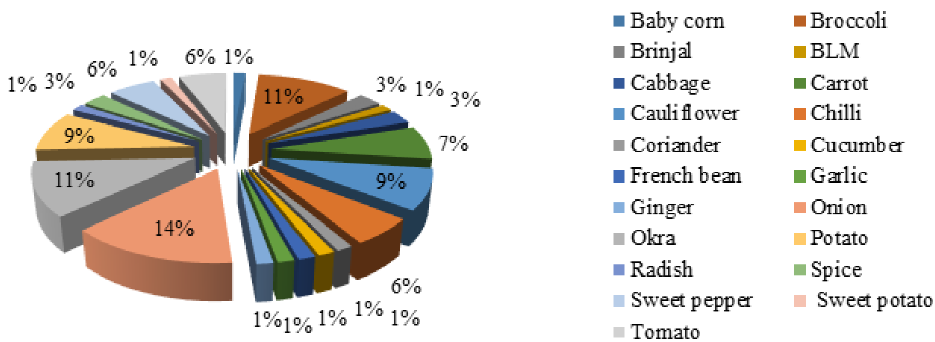

Figure 1. Major vegetable species in which research conducted at Agricultural Colleges/Universities of Nepal

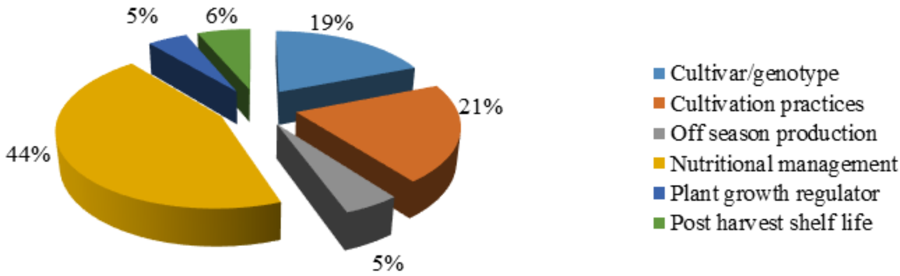

Figure 2. Aspects in which research on vegetable species conducted at Agricultural Colleges/Universities of Nepal

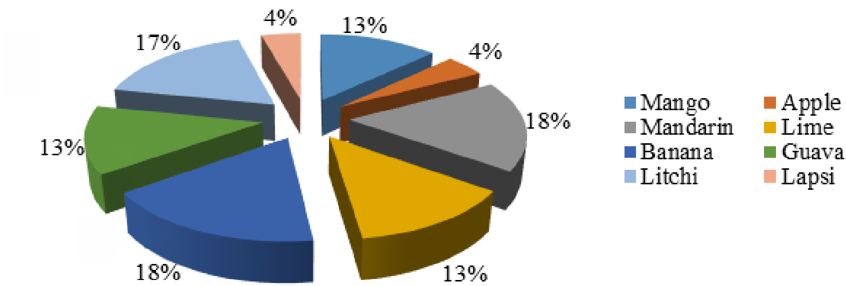

Fig 3. Major fruit species in which research conducted at Agricultural Colleges / Universities of Nepal

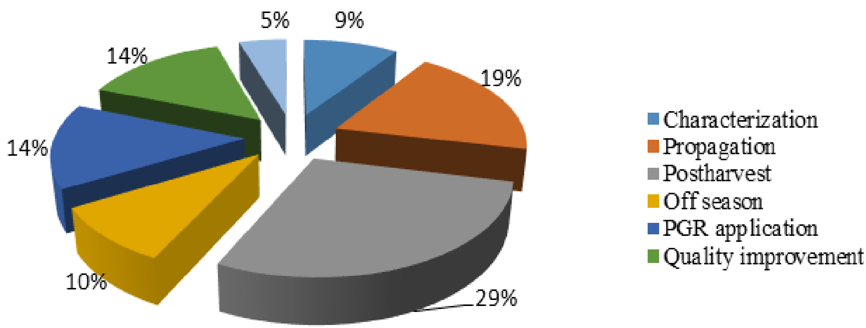

Fig 4. Aspects in which research on fruit species conducted at Agricultural Colleges/Universities of Nepal

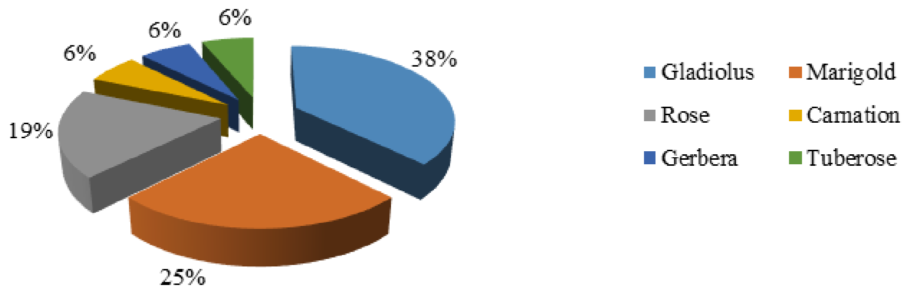

Fig 5. Major ornamental species in which research conducted at Agricultural Colleges/Universities of Nepal

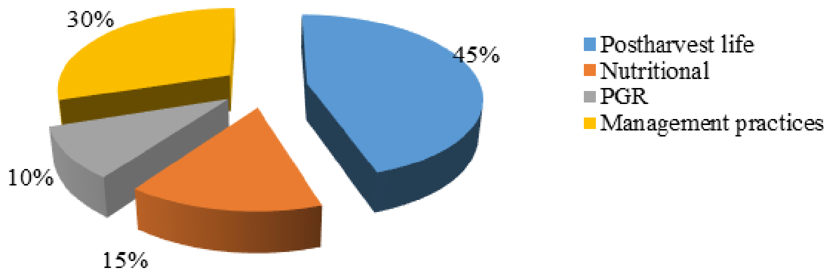

Fig 6. Aspects in which research on ornamental species conducted at Agricultural Colleges/Universities of Nepal

Potato

The proper size of seed potato, method of planting and dose of fertilizer were identified by several experiments on potato (Khairgoli, 1982; Shrestha and Dhakal, 1981; Adhikari, 2001). Similarly, measures to minimize the late blight and weed problem were also developed (Bhardwaj et al., 1981).

Tomato

Better genotypes with respect to higher yield and resistant to Phytopthora infestans as well as bacterial wilt malady were identified (Bhurtyal, 2001; Sharma et al., 1983; Khatri-Chhetri and Shrestha, 2004;

Adhikari, 1994). Similarly, 2 sprays of Ridomil reduced the disease intensity of late blight in cv. Pusa Ruby (Shrestha and Bhardwaj,1982). The total and marketable yields were higher from tomato grown with goat manure followed by chicken manure and FYM (Pokhrel et al.,1995). Bioneem was found more effective than thiodan against tomato fruit borer in Rampur, Chitwan condition (G.C. and Thapa, 2000).

Simkhada and Paneru (2010) concluded that Imadagold was most effective to manage whitefly and Alwin Xl to minimize the infestation of leaf miner in tomato in plastic house condition in the mid hill. Nisha (2015) reported that the cultivar CL 1131 was better than NS 815, NS 2535 and Swarakshya particularly in respect of plant morphological characters, yield and yield components with the use of plastic or straw mulch which proved to be the best for tomato production during autumn season by reducing weed competition, labor cost, moderating soil temperature and conserving soil moisture.

Other Fruit vegetables

The technology for the commercial cultivation of brinjal through improvement in fruit set, varietal selection, nutritional management and use of plant hormones has been developed based on the outcomes of 3 years on farm experiments (Sharma and Dahal, 2063 BS). Similarly, the technology for the market oriented cultivation of chilli through improvement in fruit set, varietal selection, nutritional management and use of plant hormones has been developed based on the outcomes of the research activities conducted in the farmer's field (Sharma and BK, 2063 BS).

Among 5 varieties of brinjal tested against shoot and fruit borer, Noorki was the least affected variety while Pusa Purple Long and Began Neelam were the most affected (Devkota et al., 2000). The highest marketable yield of brinjal was obtained with the treatment combination comprising of use of barrier + shoot clipping (Ghimire, 2001). Systemic nematicide furadan (3G) resulted in significantly higher yield in okra and egg-plant (Bhardwaj et al., 1985). Thapa et al. (2009) reported variation among brinjal genotypes regarding the susceptibility to L. orbonalis. Similarly, Poydyal et al. (2009) found no significant effect of plant growth regulators on the severity of leaf bilght, wilting and phomopsis blight of brinjal.

In spring-summer season okra, triacontanol was found the most promising PGR since it produced the highest and earlier fruit yield (Acharya, 2004). In chilli, use of 2,4-D and triacontanol increased fruit yields significantly and their use were found economically better than other PGRs like GA3 (Chaudhary, 2004). In sweet pepper farming, 2,4-D @2.5ppm was found to be promising growth regulator for spring summer crop of sweet pepper in Chitwan (Poudel, 2005). Lohani (2015) concluded that the hybrids Indra and NS 632 were superior to Sagar and California Wonder varieties under Chitwan condition. Further, hybrid Capsicum cultivation with 250 kg N/ha through chemical fertilizer in Autumn was the most profitable.

Onion

Evaluation of 25 exotic and indigenous cultivars was done along with different sowing dates (Sharma et al., 1995). Furthermore, in cultivar Red Creole, the treatment with GA3 500 ppm spraying produced significantly the highest yield (Srivastava and Sharma, 2000).

Besides manuring and NPK fertilization, application of Cu and Zn was suggested (Baral et al., 1995). Subedi et al. (2002) reported that the highest bulb yield was obtained under 100% soil moisture regime and 10 days irrigation frequency followed by 5 days irrigation frequency in the same soil moisture regime. While cultivating onion using sets, it was found that the yield was highly influenced by the size of sets(Kurmi, 2003).

Cucurbits

The technology for production of cucumber during off and normal season has been developed based on the 3 years research in different locations of Nepal (Sharma et al., 2059). In Bitter gourd, Creeper variety was found better than Green Long as the latter was more prone to attack by fruit fly than Creeper (G.C. and Mandal,2000). The fruit fly trap containing Cuelure and Malathion 50 EC was found effective in minimizing at the earlier stages of the crop (G.C., 2000-2001). Similarly, to control red pumpkin beetle synthetic pyrethroids (deltamethron @ 0.004%, Cypermethrin @ 0.012% and fenvelerate @ 0.01%)) were found effective (Thapa and Neupane, 1992). In summer squash, fresh leaf extract of Artemisia vulgaris was found effective against this insect (Neupane and Neupane, 1993).

In chayote, different Nepalese landraces along with Mexican and Cost Rican landraces were collected and evaluated regarding the morphological, reproductive, post harvest life and disease resistance (Sharma, 1994; Sharma and Neupane, 1994; Gautam and Sharma, 1995;Shrestha and Sharma,1998-99).

Cole crops

On the basis of findings of several experiments, proper doses of N, P and B were identified for commercial cultivation of cole crops (Khatri-Chhetri et al.,1979; Lucite, 2003;Dhakal et al., 2009;Sriwastav and Sah, 2009). Further, while transporting the curds, the paper wrapped crate packaging was the most preferable than others. The medium sized curds (0.5-1 kg) were the most appropriate grades as per consumer's preference (Gautam and Khatiwada, 2060).

In Chitwan, the highest seed yield of broccoli was obtained with Apis mellifera pollination followed by A. cerana pollination while it was the lowest with control/natural pollination (Devkota et al., 2003). In another experiment, lower intensity of alternaria disease with resultant increase in seed yield was recorded with higher dose (60t/ha) of FYM than lower dose of FYM (20t/ha) (Neupane, 2004). According to Shrestha (2015), planting of broccoli seedling of Calabrese variety on 1st November at 60 cm × 50 cm was better for higher seed yield, more benefit and better seed quality.

Root Vegetables

Among 7 cultivars of radish, the cultivar Chinese-1 produced 3.5% higher marketable root yield than Mino Early. Cherry Belle produced the lowest marketable root yield but was more suitable for salad purpose (Sah, 2002). In one experiment on carrot, application of well decomposed FYM @ 30t/ha and harvesting at 100 days after sowingwas suggested for high quality organic carrot production(Gotame, 2003).

Spices

Chaulagain et al. (2010) concluded that among ten cultivars of coriander tested Coriander Local was superior with respect to disease tolerance and seed spice yield. Chaudhary (2013) assessed the genetic variability in large cardamom by using morphological and Rapd markers. Further, Rawal (2014) studied the performance of cumin varieties at different sowing dates in Salyan, Nepal.

Citrus

Integrated management technologies for the management of citrus decline in mandarin orchard has been developed from 3 years research conducted in 3 different altitudes of mid hills of Nepal (Subedi et al., 2060). Experiment on post harvest management resulted in the standardization of maturity stage at harvest, preharvest application of GA3 and proper packaging as well as post harvest treatment with respect to improved shelf life of mandarin (Thapa and Gautam, 2002; Bhusal, 2002).

Research works at Rampur for more than 6 years identified many potential landraces of lime and lemon. Similarly, technique to produce off season lime has been standardised (Tripathi and Dhakal, 2005). In grafting experiment, the highest graft success (79.73%) was obtained when acid lime was grafted onto Trifoliate orange on 31 January (Adhikari et al., 2007).

Guava

Research on guava, especially to mitigate wilt problem,was conducted from 2003 to 2006 at Rampur, Chitwan under the financial assistance of Hill Agriculture Research Project (HARP) (Shrestha et al., 2004). Causal agent of the guava wilt was identified. More than 51 landraces/cv/sps were collected and maintained in fruit orchard at IAAS, Rampur. Resistant rootstock (Chinese guava) was confirmed and the grafting with the utilization of this resistant rootstock was found successful. Further, relationship between the acidity and wilt disease has been established

(Shrestha and Shrestha, 2004). Under the financial support of NARDF, research on off season production of guava fruit, and techniques to maintain the post harvest life was identified (Shrestha and Bhattarai, 2066 BS).

Pineapple

In Queen and Kew cultivars, chemicals to induce uniform flowering were standardized (Dhakal et al.,1981; Shrestha and Thapa, 1989; Shrestha,1987). In pineapple orchard, the most effective method for suppressing weed was Glyphosate sprays (Baral et al., 1993).

Banana

The appropriate planting time, spacing and number of suckers/ clump under Chitwan condition were found (Gautam and Gautam, 2002). In another experiment, Pant (2005) concluded that for high quality banana production, it seemed necessary to apply 300g lime and 300g K/plant. The systemic insecticide Umet reduced the scaring beetle population 100% while the botanical pesticide annosom resulted in 84% reduction over control (Thapa and Tiwari, 2007).Technique to induce artificial ripening was suggested after conducting experiment under the financial support of NARDF (Gautam and Khatiwada, 2005).

Papaya

Boron nutrition is essential for successful papaya production (Shrestha and Baral, 1993). Further, 100 ppm ethrel produced more female flowers. Four genera of nematodes were suspected as one of the factors of papaya decline in Chitwan (Yadav et al., 1993). Similarly, 9 plant parasitic nematodes were recorded in papayaplants among which Pratylenchus and Meloidogyne were more favored by papaya (Pokharel et al.,1994).

Mango

Technique to induce flowering during off season in mango using paclobutrazol was generated (Karki and Dhakal, 2003). In epicotyl grafting, veneer method on 3 week old rootstock appeared to be the most potent treatment combination for greater success of epicotyl grafts (Poon and Shrestha, 2002).While studying the post harvest life of mango, Badal (2015) concluded that the use of CaCl2, hot water treatment and the use of cushioning material were useful practices.

Litchi

Application of plant hormone NAA resulted in maximum fresh weight, pulp weight, fruit size, TSS and TSS/acid ratio (Sigdel, 2005). Similarly, the problem of fruit cracking could be alleviated by spraying of plant growth regulators. Ethephon 10 ppm was the most effective treatment (Shrestha, 1981).To enhance the storage quality, colour, and other physio- chemical parameters of litchi fruit it, after harvest, should be treated with oxalic acid @ 10% and KMS so that fruit could be kept in normal condition for 10 days (Yadav, 2015)

Ornamental Crops

Among 66 cultivars of rose subjected to moderate level of pruning, Edith-Nalli Perkins was the highest yielder among 34 cultivars that came into flowering (Pun, 1994). While standardizing the media for orchid, sphagnum moss seemed superior and applicable for commercial purpose (Pun et al., 1995).Appropriate dose of nitrogen and phosphorus for gladiolus was identified (Pant, 2005). In gladiolus, predictive model to estimate the days to spike harvest at first basal floret showing color break along with better cultivar and post harvest solution for better vase life was developed for Chitwan condition (Regmi, 2000). Asmita (2015) has concluded that spraying of GA3 at 100 - 150 ppm on gladiolus gavesuperior cut flower characteristics with better postharvest life of flower and maximum production of corm and cormels.Acharya et al. (2010) concluded that both locations and varieties had effect on vase life of gerbera and that among different cultivars Sunway variety had the longest vase life.

WAY FORWARD

Horticultural researches in Nepal are not only done by academia and public organizations. Non-state actors, which are also actively working all across the country, are also involved in horticulture research. The research outputs came out from the non-state actors may or may not be streamlined in the main course. But all the technologies developed and/or adapted/acclimatized in the country should be placed in a basket so as to effectively utilize the scarce financial resources, mobilize the limited qualified professionals and generate better impact out of limited investment. Upon analyzing the research history of horticulture in Nepal, the issues presented hereunder would be worthwhile to consider for its effectiveness:

Horticultural research policy: In the context of not having agriculture research policy in the country, demand of horticultural research policy would be more ambitious. Considering the gradual growth of horticulture in AGDP and about 35% contribution at present, government should give top priority to formulate horticulture research policy without any delay. The pathetic situation of horticulture research in Nepal might be due to poor guidelines and leadership. We believe that the situation would be different if the Horticulture Master Plan drafted in 1990 would have been formally endorsed by the government.

Government core fund for capacity building: Poor external funding and CGIAR support on horticultural sector have directly impacted on poor capacity building. Poor external investment means that there is less attraction to researchers to involve in it. Considering the recent technological demand like hybrid, protected cultivation, precision agriculture for high value commodities along with niche crop like large cardamom government should set core funds for capacity development. "One size fits all" philosophy is not going to contribute horticulture research in this country.

Expert consortium: Since very limited number of qualified professionals are involved in horticultural research in the country, it is suggested to formulate a consortium of experts working in academia, research institute, private sector and NGOs. This expert team should be made responsible for prioritizing broad research areas and potential collaboration among the actors. National Horticulture Research Institute, as proposed by ADS, could play role of secretariat for its implementation.

Establishment of College of Horticulture:With the establishment of Agriculture and Forestry University it has been expected to speed up the horticulture research in the country. But it is noteworthy to mention that the faculties of the university are obtaining funds mainly from the competitive grant system of various national and international institutions. Further, there is urgent need to establish a college of horticulture as mentioned in the long term plan of AFU.

Market led research: The research agendas to be prioritized by the expert team should come from the grass root institutions and front line workers. Annual gathering among commodity associations, extension workers of I/NGOs and processing industries would be the appropriate venue for the generation of market or client's demand driven research agendas.

Technology registration: In the context of not having technology registration process, clear inventory of horticultural technologies are not available. In many cases, conflicting recommendations are also seen in horticultural publications. A system of technology recommendation need to be in place and NARC could be the focal point for the same. More importantly, it should have the legal rights as that of variety releasing committee.

REFERENCES

Anonymous, 1961. Horticulture Development Programme. Indian Aid Mission.

IAAS Journal Vol 1(1977) to Vol 33 (2012). Published by the Institute of Agriculture and Animal Sciences,TU, Rampur.

IAAS Research Advances (Vol I and II). Published bythe Institute of Agriculture and Animal Sciences,TU, Rampur.

IAAS Research Reports (1982-2000). Published bythe Institute of Agriculture and Animal Sciences,TU, Rampur.

Krishi, Fruit Special (Kartik-Mangsir, 2032 BS). Agri. Information Division. DoA/ Nepal Agri. Extension Project. Dec., 1978. Phase 2 Vol. 1.

Nepal Agricultural Research Council, 2014. Annual Report 2069/2070 (2012/2013). Nepal Agricultural Research Council, Singhadurbar Plaza, Kathmandu.

Nepal Agricultural Research Council, 2015. Annual Report 2070/2071 (2013/2014). Nepal Agricultural Research Council, Singhadurbar Plaza, Kathmandu.

NARC's Strategy Vision for Agricultural Research (2011 – 2030). Internet access on 6th. October 2015.

Paudyal, K.P. and N. Subba (compiled), 2012. Bibliography of Horticultural Research in Nepal (1968-2012). Horticulture Research Division, National Agric. Res. Council, Khumaltar.

Paudyal, K.P. and P.P. Khatiwada, 2015. Current status of resource allocation for horticulture research under Nepal Agricultural Research Council. In Proceedings of 8th Horticultural Seminar. NARC, NHS and AFU, Kathmandu.

Post Graduate Theses of Department of Horticulture, Institute of Agric. and Anim. Sciences, TU and Agriculture and Forestry University (2000-2015).

Sijapati G. B., 1961 (2018 BS). Udyan (horticulture) (In Nepali).

Shah, R. B. and B. B. Basnet, 1983 (2040 BS). Bagwani (Horticulture), Tribhuvan University, Kathmandu: pp 1-5 (In Nepali).

Shah R. B., 1975. Travelling reports of Jumla and Mugu districts of Nepal, Falgun-Chaitra, 2031 BS (In Nepali).

Shah R. B., 1976/77 (2033/34 BS) Lapsi (a booklet in Nepali). Agri. Information Division, DoA.

CITRUS RESEARCH AND DEVELOPMENT IN NEPAL

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ABSTRACT

Citrus species mainly mandarin, sweet orange and lime are major fruit crops of Nepal. Government of Nepal has given high priority for research and development (R and D) of citrus in mid-hill region of the country. Since 1960s systematic R and D efforts were made from public sector resulting to evolution of various institutions including donor aided projects to commercialize these crops. Technologies are generated on variety improvement, nursery management, orchard husbandry, plant protection and post-harvest aspects. Commercial production has been expanded to nearly 50 districts of the country. Despite all the efforts Nepal is still importing significant quantity of citrus fruits annually. In this context, this chapter presents various research activities undertaken in the past along with their significant results. Additionally, extension and technical delivery mechanism and production and export- import trend are also briefly stated.

BACKGROUND

Citrus species constitute major fruits of Nepal in mid-hill region. Nepal has suitable agro-climatic conditions for quality citrus fruit production in mid-hills ranging from 800-1500 m altitude. Although there are many citrus species grown in Nepal, mandarin (*Citrus reticulata* Blanco), sweet orange (*Citrus sinensis* Osbeck) and acid lime (*Citrus aurantifolia* Swingle) are cultivated in commercial scale. Hill lemon (*Citrus pseudolimon*), commonly known as *Nibuwa* in Nepali is also a popular species in Nepal for juice and pickle production.

Scientists believe that citron and mandarin were originated in this part of the world and are being grown since pre-historical period. Citrus fruits are also associated with Nepalese cultures and rituals. Citron (Bimiro) is one of the items needed during *Bhaitika, Mahapuja* and *Chhat* festival. Economically citrus is 4-5 times more profitable than cereals in hill terraces and slopes (Gauchan, 2000). There is plenty of scope of increasing production for domestic and export markets. Nepal Government has given priority for research and development (R and D) of citrus fruit crops since decades including recent policy documents such as Agriculture Perspective Plan (1995) and Agriculture Development Strategy (2015). Therefore, this report tries to gather overall information on various efforts made on R and D of citrus fruit crops from different organizations in Nepal.

HISTORICAL PERSPECTIVE

Mandarin and citron are considered indigenous crops of Nepal. Chinese travelers have mentioned Nepal as "the country of golden fruits" in about 2000 years ago when they saw the yellow color of mandarin fruits at ripening (Lohar and Lama, 1997). 'Suntala' the Nepali name for mandarin means golden story which has similar meaning as described by Chinese travelers. The Sanskrit word for mandarin is 'narangi' which also indicates the antiquity of the crop to Nepal. Bonavia (1890) as cited by Shrestha and Verma (1998) has considered mandarin as an indigenous fruit of Nepal. Tanaka (1954) considered the Himalayan foothills throughout subtropical range from eastern corner of Burma, Assam, and Sikkim to Punjab as the native habitat of *Citrus medica* and *C. limon* and termed this region as Medica-Limon chain. Farmers of Darchula and Shakhuwasava district claim that their forefathers had collected mandarin trees from wild form (Shrestha and Verma, 1998). These historical facts clearly indicate that citron, mandarin and hill lemon (Nibuwa) are native fruits of Nepal and being cultivated from pre-historical period. Other species like sweet orange, lime, pummelo are relatively new introduction to Nepal.

INSTITUTIONALIZATION OF CITRUS R AND D

Although citrus are historical fruits Nepal, systematic research and development of citrus was initiated from 2013 along with periodical development plans of Nepal. It gradually evolved as described below.

- Citrus R and D was initiated by establishing Citrus Research Station in Dhankuta and Sub Station in Pokhara in 1961 (BS 2018) with the support of the Indian Aid Mission (IAM). In 1966 (BS 2022) name Citrus Research Station, Dhankuta and Sub Station, Pokhara was changed to Agriculture and Horticulture Research Station respectively.

- In BS 2020, the first horticulture seminar was held at Horticulture Research Station, Kirtipur. Junar fruits from Dhankuta were exhibited in the seminar. Junar cultivation in Sindhuli particularly at Ratanchura area was specially discussed first time at the seminar and regarded as an important commodity for Nepal.
- National Citrus Development Program (NCDP) was established in 2029 BS (1972) in Pokhara and moved to Dhankuta in 2031 giving full responsibility for citrus R and D of the country. In 1977 (2034) Horticulture Research Station, Dailekh was established in Mid-western region with major mandate on citrus. Thus, Dhankuta, Pokhara and Dailekh Stations were identified as major centers for citrus R and D. Agri. Sindhuli, Papa and Dhunibesi Horticulture Farms were also attached with Citrus Development Program at that time.
- Dhankuta Agriculture Research station was handed over to Nepal Agricultural Research Council (NARC) after the establishment of NARC in 2048 and named as Agriculture Research Station (Horticulture) Dhankuta. From July 2000 (Shrawan 2057 BS) the station was officially recognized as National Citrus Research Program (NCRP).
- In 2050, NCDP was moved to Kirtipur from Dhankuta under Department of Agriculture. In 2060 (2003) Horticulture Centre, Palpa was recognized as Citrus Development Centre, Palpa.
- Horticulture Development Project (HDP) was implemented with the support of Japanese government from 1985 to 1997 with the objectives of increasing production of citrus (mandarin and sweet orange) and deciduous fruits through technological development, training and extension in six districts – Sindhuli, Ramechhap, Kathmandu, Nuwakot, Banke and Bardiya in first phase and in Sindhuli, Ramechhap, Kavre, Kathmandu, Lalitpurand Bhaktapur districts in second phase. Some exotic citrus species and varieties were introduced from Japan and established evaluation blocks at

Horticulture Centre, Kirtipur. Studies on evaluation of local land races (mandarin, sweet orange and pummelo), cultivation techniques, rootstock evaluation, harvesting and storage techniques were carried out. Long and short-term training to JT/JTA and farmers and establishment of demonstration farms were other activities of the project.

- With the objective to increase the production of mandarin and sweet orange government launched citrus priority program in Dhankuta, Sindhuli, Ramechhap, Kaski and Dailekh districts in 1985 focusing on to increase citrus area, establish nurseries, training to farmers and demonstrate integrated orchard management approach (Shrestha and Verma, 1998).
- Asian Development Bank provided loan assistant to implement Hill Fruit Development Project in 11 hill and mountain districts of Eastern Development Region from 1985 to 1995. Main thrust of the project was to increase the production of citrus in mid-hill region, apple in temperate region and banana and pineapple in terai and lower altitude. It supported to improve research facilities at National Citrus Research Program, Dhankuta, to improve extension services, construction of market yards and cellar storage and establishment of nurseries in private sector.
- Hill Agriculture Research Project (HARP) implemented with financial support of British Government introduced competitive grant system (CGS) first time in Nepal in Agricultural Research. The project was implemented from 1997 to 2004. It is estimated that HARP supported at least Rs 40 million for 13 citrus research projects (Table 1).

Table 1. Research Projects funded by HARP.

SN	Name of the project	Duration	Implementing organization
1	Management of fruit drop in mandarin	1998-2001	ARS Dailekh
2	Improvement of post-harvest shelf life and marketing of mandarin orange in the hills of Nepal	1999-2002	ARS, Lumle
3	Improvement of post-harvest shelf-life of horticultural commodities (citrus, apple, tomato and cauliflower) in the hills of Nepal	2000-2003	IAAS Rampur
4	Integrated mandarin tree health improvement research in the hills of Nepal	1999-2001	ARS, Lumle
5	Integrated citrus rehabilitation research in the hills of Nepal	2000-2003	IAAS, Rampur
6	Citrus decline research in the hills of Nepal: development and use of tissue culture technology against citrus decline	2000-2003	GREAT Nepal
7	Citrus declining management project in the hills of Nepal	2000-2003	IAAS Rampur
8	Development of improved package of technologies for increased productivity and quality of mandarin orange in eastern hills of Nepal	2000-2003	NCRP, Dhankuta
9	Marketing of mandarin orange (Citrus reticulata) in Nepal.	2000-2001	IAAS, Rampur
10	Promotion of marketing of high value agricultural commodities (citrus and vegetables) to Bangladesh and Tibet markets	2001-2003	ABTRACO
11	Management of citrus green stink bug through integrated approaches	1999-2002	ARS, Lumle
12	Regulation of flowering for off-season production of lime and lemon in the hills of Nepal	2000-2003	IAAS, Rampur
13	Breaking Seasonality for off-season lime and lemon production in the hills of Nepal	2000-2003	IAAS Rampur

Source: HARP, 2001 and HARP, 2004

- After the phase out of HARP, government of Nepal created National Agriculture Research and Development Fund (NARDF) in 2001 to continue the CGS in agriculture research and development. NARDF has been funding R and D projects. The citrus related projects completed by 2010 are listed in table 2.

Table 2. NARDF funded citrus research projects completed by 2010

SN	Name of the project	Duration	Implementing organization	Project cost
1	Improvement of post-harvest handling and marketing system of mandarin orange in Dhading, Gorkha and Lamjung districts.	2004-2007	GREAT, Nepal	2,95,100
2	Selection and dissemination of elite genotype of acid lime and hill lemon for off-season production in the hills and terai of Nepal.	2004-2007	IAAS, Rampur	2,534,715
3	Improvement of production and quality of citrus fruits through sustainable soil management practices in FWDR of Nepal.	2005-2008	NCRP, Dhankuta	1,745,700
4	Productivity improvement of citrus fruits through effective fruit drop management techniques in the mid and far western development regions of Nepal.	2006-2009	NCRP, Dhankuta	1,993,295
5	Mitigation of citrus decline problem in western hills of Nepal through integrated management of huanglongbing disease.	2008-2011	NCRP, Dhankuta	2,798,525

Source: NARDF, 2008 and 2010.

- At present, National Citrus Research Program (NCRP) under NARC and National Citrus Development Program (NCDP) under Department of Agriculture (DOA) are the two government institutions solely involved on citrus research and extension respectively.
- NCRP is primarily involved on germplasm collection and conservation, variety selection to increase production season, quality and productivity, nursery management, soil and nutrient management, citrus fruit fly and other insect control, dissemination of technologies to farmers' fields and nationwide coordination on citrus research activities at present.
- Major role of NCDP is to provide extension services to citrus growers in the form of **regular** and **special programs.** Regular programs are either implemented directly by NCDP (central level program) or through District Agriculture Development Offices (DADO). Central level regular programs on citrus fruit crops include study and observation, monitoring and supervision, fruit exhibition, nursery and commercial orchard competition at national level, technical support to districts, collection and update citrus statistics and information at national level and support government on developing citrus policy and its implementation. Regular extension programs implemented by DADO include technical and financial support to farmers' for commercial citrus orchard, private nurseries and homestead garden establishment, trainings, tools distribution, problem solution campaign, cellar store establishment, orchard management demonstration, nursery and commercial orchard competition, organize farmers' tour and exhibition, collection centre establishment, district level information compilation and other technical services as needed (NCDP, 2071 BS).

Considering the importance of citrus fruits some special programs are also being implemented in Nepal. NCDP is taking leading role to implement such programs. Special projects are briefly described below:

Mission Program (Kagati): With the objective to decrease import of acid lime (kagati) the program was launched from 2064/65 in ten districts of the country. In first phase (2064/65) Bhojpur, Terathum and Dhabkuta district were included. Makawanpur was added in the second phase (2067/68) and another six districts namely Nuwakot, Nawalparasi, Palpa, Gulmi, Surkhet and Jajarkot were included in the third phase (2070/71). Major activities of the mission program are (i) screen house construction for mother plants at DOA farms (Kirtipur and Palpa) (ii) area expansion of lime (iii) lime sapling production (iv) nursery establishment at government and private sector (v) construction of irrigation water collection pond (vi) drip irrigation demonstration and (vii) training, workshop, interaction, visit, audio-visual production.

Value Addition Program: In FY 2066/67 and 2067/68, the program was implemented to improve fruit quality and commercial market promotion in Panchthar, Dhankuta, Gorakha, Tanahu, Syanja, Parbat, Argakhachi, Dailekh and Dadeldhura, Gulmi, Salyan, Rolpa and Kailali districts.

Budget Speech Program: In FY 2068/69 the program was executed through District Agriculture Office of Panchthar, Dading, Syanja, Parbat, Salyan, Dailekh, Gorkha and Nawalparasi.

Citrus Orchard Improvement Program: In FY 2070/71, the program was executed in Dhading, Gorkha, Lamjung, Tanahu, Kaski, Syanja, Parbat and Myagdi districts to improve declining orchards. Subsidy was provided @ Rs 76,000 per hectare for 50 hectares in each district. The program was continued in FY 2071/72 to cover 20 ha per district with same amount of subsidy.

AREA AND PRODUCTION

Fresh Fruit Production

Citrus fruits are priority commodities of government. Various institutions and development programs are engaged in the promotion of citrus industry in the country. As a result of past efforts area and production of citrus fruit crops increased significantly over the years (Table 3). However, production increase is mainly attributed to area expansion.

Despite numerous efforts on R and D of citrus through regular government program and time bound special projects as mentioned in above section the productivity of citrus in Nepal is very low and ironically it is in decreasing trend in recent years. Mandarin contributes about 65% in production followed by sweet orange (16 %) and acid lime (11 %) (table 4).

Table 3. Area, production and productivity of citrus fruit crops.

Year	Total area (ha)	Productive area (Ha)	Production (mt)	Productivity (mt/ha)
2000/01	20,673	11,892	121,665	10.23
2001/02	22,423	12,615	130,928	10.38
2002/03	23,663	13,312	139,110	10.45
2003/04	24,799	13,931	148,010	10.62
2004/05	25,910	14,606	156,956	10.75
2005/06	26,681	15,206	164,075	10.79
2006/07	27,980	15,832	171,875	10.86
2007/08	30,790	19,915	226,404	11.37
2008/09	32,322	22,482	253,766	11.29
2009/10	33,898	22,903	259,191	11.30
2010/11	35,576	23,607	263,710	11.20
2011/12	37,565	24,089	240,793	10.00
2012/13	36,975	23,645	216,188	9.14
2013/14	38,987	25,497	224,356	8.80

Source: Statistical information of Nepalese Agriculture 2013/14, MoAD

Table 4. Production share of different citrus fruit crops in 2013/14

Crop	Total area (ha)	Productive area (ha)	Production (mt)	Productivity (mt/ha)
Mandarin	25,407 (65.2)	16,527 (64.8)	149,315(66.6)	9.0
Sweet orange	4,996 (12.8)	3,504(13.7)	35,393(15.7)	10.1
Lime	6,432(16.5)	3,724 (14.6)	25,582(11.4)	6.9
Lemon	964 (2.5)	807(3.2)	6,667 (3.0)	8.3
Others	1,186 (3.0)	934 (3.7)	7,364 (3.3)	7.9
Total	38,987 (100)	25,497 (100)	224,356 (100)	8.8

Note: Figures within parenthesis are percent of total

Source: Statistical information of Nepalese Agriculture 2013/14, MoAD

Planting Materials

Citrus planting materials are mainly produced by private nurseries which are distributed throughout the country. Although of seedling as planting materials was stopped more than 100 years ago in developed countries in Nepal even now most of the planting materials used by the farmers are seedling origin (Table 5). Thus, use of seedlings and poor quality vegetative propagated materials is one of the reasons for high mortality of planted trees and low productivity.

Table 5. Number and type of citrus planting material produced in 2070/71 (2013/14).

Sector/ region	No. of nurse-ries	Mandarin		Sweet orange		Lime		Total
		Grafted	Seedling	Grafted	Seedling	Grafted	Seedling	
Private								
Eastern region	24	76000	267500	5000	49000	14200	140600	552300
Central Region	23	71500	65600	83500	0	500	238700	459800
Western Region	37	197700	258750	12000	6000	2400	66650	543500
MW region	38	8000	132300	500	38800	0	41550	221150
FW region	7	400	12650	183	11660	0	13800	38693
Sub-total private	129	353600	736800	101183	105460	17100	501300	1815443
Government								
DOA	2	8700	2500	3500	0	800	10000	25500
NARC	1	2654	0	232	0	3934	0	6820
Sub-total Gov.	3	11354	2500	3732	0	4734	10000	32320
Grand total	132	364954	739300	104915	105460	21834	511300	1847763
% grafted saplings		32.8		49.8		3.4		26.2

Source: Annual Report of NCDP, Kirtipur and NCRP Dhankuta (2013/14).

RESEARCH AND TECHNOLOGY GENERATION

Diversity Study and Variety Improvement

Diversity study and evaluation of local and exotic germplasm has been a major component of citrus research in Nepal since the establishment of National Citrus Research Station, Dhankuta in 2018. Lama et al. (1984) found locally collected sweet orange genotypes - Junar-LS, JunarSyj-S and Junar-HM and mandarin genotype GRKH superior upon field evaluation at Horticulture Station, Pokhara. Various exotic sweet orange varieties introduced from India during 1960s were stablished at Horticulture Station, Pokhara and Citrus Research Station, Dhankuta. The plants at Pokhara station died later because of Huanglongbing diseases. Trifoliate orange and other rootstock species and hybrids were also introduced during that period. Till the date trifoliate orange is commonly used rootstock for grafting scion varieties.

Hill Fruit Development (HDP) further introduced mandarin, sweet orange and pummelo varieties from Japan and established at Horticulture Centre, Kirtipur. In 2005, NCRP, Dhankuta introduced a total 31 new scion varieties including mandarin (16), sweet orange (6), grapefruit (4) and tangor (3) and tangelo (3) from INRA-CIRAD, France. These varieties are being evaluated at NCRP, Dahnkuta and at farmers' field. In addition to scion varieties, seven rootstock varieties were also introduced from France. Table 6 presents various citrus germplasm maintained at government farms.

Table: 6. Indigenous and Exotic genetic resources maintained at different stations.

Species	Stations	
	NCRP, Dhankuta	CHRS, Kirtipur
Common mandarin (Suntala)	Bashkharka local, Sikkime, Khoku selection, Gorkhalisuntala, Pogan, Kamala, Fortune, Kara, Nova, Pixie, Dancy, Avana, Page, Hernadina, Oroval, Commune, Marisol, Nules, Kinnow, Frutrel early, Kalamadarin	Clementine, Dekopongan, Frutrel early, Hayaka, Kiyomi, Kinnow, murkott, Ota pongan, Thai tangarin, Yoshida pongan.
Satsuma mandarin	Miyagawawase, Okitsuwase, Satsuma wase, URSS Satsuma, Unshiu (NCRP 04)	Imamura unshu, Miyagawawase, OkitsuWase, Miyauchi Iyo, Aoshimaunshu, Otsu-4
Sweet orange (Junar)	Dhankutajunar, Blood red, Cara Cara, Delicious seedless, Hamlin, Lane Late, Madame Venous, Malta Blood Red, Meisheu-9, Mosambi, Navalencia, Newhall Navel, Pineapple, Ruby, Salutsiana, Samauti, Sevelle Common, Skage Bonanza, Succari, Valencia late, Vanelle, Washington Navel, White Taker, Yoshida Navel, Tomango.	Fukuwara-1, Fukuwara-4, Kiyomi, Nepali Junar, Malta Blood Red, New Taracco, New Valencia, Washington Navel, Yishida Navel.
Acid lime (Kahati)	20 accessions collected from Nepal. Among then two (Sun Kagati-1 and Sun Kagati-2) released.	Local, Madrasi
Lemon (Nibuwa and Chasmekagati)	ChasmeKagati: Ureka, Panta-1 Nibuwa: Dhanuta collection, Thimura local, BRT Nibuwa, Prembasti local	Lisbon, Ureka
Tangor (Tangarin x S. orange)	Ellendale, Murkott, Ortanique, Murkot (seedling)	Murkott
Tangelo (Tangarin x pummelo)	Minneola, Orlando, Seminole	Orlando
Grapefruit	Shamber, Hendeson, Star Ruby, Reed, Pink Rubi	Unidentified variety -1

Pummelo (Bhogate)	Nam Roi, Phultrac, Phodium	Amanatu, Ohtachibana, Banpeiyu, Kawachibankan, Thai pummelo, Local collections
Kumquat (Muntala)	Oblong type, Round type	Oblong type, Round type
Rootstocks	Trifoliate orange: Trifoliate (unknown variety), Pomeroy, Flying dragon Citrange: Carrizo, C-35, Troyer Others: Citrumelo, Rangapur lime, Volkameriana, Rough lemon.	Trifoliate orange: Trifoliate (unknown variety), Rubid, USDA Citrange:Carrizo, Troyer

Source: Gotame et al., 2014

Seedling plants of local mandarin germplasm from 10 districts (Dailekh–Gamaudi, Gulmi–Bhatkhola, Palpa-Rupse, Syanja-Bahunmara, Kaski-Pokhara, Tanahu-Jamune, Dhankuta-Khoku, Shankhuwasabha-Mantewa, Terathum-Piple and Illam-Namsaling) were collected in 2034 and established in evaluation plot at Dhankuta Agriculture Station in 2035 BS (DAS, 2046). These germplasm were not continuously evaluated to generate conclusive results possibly due to frequent changes in organization setup and transfer of researchers. After long gap Hockey et al. (1996) classified these genotypes based on morphological characters using multivariate cluster analysis technique.

In 2039, Kinnow mandarin plants were presented to late king Birendra by the then Pakistani President Mr. Zia Ul Haq. These plants were planted at Horticulture Farm, Panchkhal, Palpa, Agri. Centre Dhankuta, Terahara, Jankapur, Nawalpur (Sarlahi), Trisuli, Nepalganj, Surkhet and Doti. Initial performance report of these Kinnow plants is available in Seventh Five Year Plan Report of National Citrus Development Program (NCDP, 2047). However, the conclusive results of the research were never published. Possibly evaluation was not continuously undertaken in succeeding years. At present, Kinnow plants in most stations have already perished while Nepal is importing significant quantity of Kinnow annually from India (Table 8).

Pahari and Bimba, (2004) revealed phenotypic variation in *Citrus reticulata* and *C. limon* population of Nepal through isozyme analysis.

Shrestha and Paudyal (2004) found Khoku superior for fruit quality from among evaluated from various pockets of Dhankuta district. In another study a total of 26 mandarin seedling trees of 25 years age, collected from Khoku and maintained at NCRP, Dhankuta, were evaluated for yield and fruit quality (Paudyal et al. 2011). Tree number: J-90 which obtained highest score (18) in selection parameters and free from graft-transmissible diseases (indexed in Nepal and Corsica, France) and was selected as mother plant. Since J-90 was the tree was multiplied, primary mother plants maintained under screen house condition at NCRP, Dhankuta and saplings supplied to private nurseries for secondary mother plants. Paudyal and Chalise (2007) evaluated two satsuma mandarin varieties namely Okitsuwase and Miyagawawase to explore the possibility of early production in under plastic house and open field conditions. The fruit taste was found sweet enough when TSS/TA ratio crossed 6 and this value is recommended as maturity index for these varieties. TSS/TA reached 6 in first week of September in Okitsuwase and 10 days later in Miyagawawase under plastic house condition with annual maximum mean temperature 32^0 C, minimum temperature of 14.4^0 C and total heat unit of 3639. The trees grown under plastic house produced better quality fruits earlier. Based on this information the researchers have recommended the areas between 900-1000 meter altitudes for quality fruit production of these varieties.

Paudyal and Subedi (2008) evaluated 14 sweet orange varieties of NCRP, Dhankuta for fruit quality and maturity period. Washington Navel and Nevelencia were selected for early season (November-December) and Valencia Late, Sevelle Common and Leu Gim Gong identified for late season (March-April) production. Paudyal and Shrestha (2004) evaluated 32 trees (11 trees from hills and 21 from Terai) of acid lime grown in farmers' fields. Nine genotypes selected from *in situ* characterization were further evaluated in multi-location trial. As a result of these study two lime varieties namely Sun Kagati-1 (NCRP-55) and Sun Kagati-2 (NCRP-49) have been released from National Seed Board in 2015 for Terai and river basin areas. These are the first fruit varieties released in Nepal by National Seed Board. Paudyal (2000) carried out farmers' participatory survey in Terai and mid-hills Nepal to assess the diversity, farmers' preference for quality fruit and to select superior pummelo tree. In this study, a total of 132 trees from 114 homestead gardens were evaluated. A wide range of variation in fruit shapes, size, pulp color, tree shape, weight, pulp content, juice content, TSS, TA and taste was recorded. Six superior genotypes were selected based on farmers' preference criteria.

Propagation

Asexually propagated planting materials have many advantages over seedling type. Until 1970s all citrus planting materials used in Nepal were seedling origin. During 5th Five Year Plan Period (1975/76-1979/80) rootstock trial on mandarin and sweet orange was initiated by National Citrus Development Program in Dhankuta and Pokhara for the first time in Nepal using different rootstock species (NCDP, 1978). Among the evaluated rootstocks Troyer citrange, Carrizo citrange and Citrus macrophylla were recommended based on their tolerance ability to Phytopthora root rot. Despite the recommendation these rootstocks were never used in Nepal for commercial sapling production. NCDP also studied appropriate date of shoot tip grafting of sweet orange on trifoliate orange rootstocks at Dhankuta and recommended that last week of December to last week of February is appropriate period with over 90% success in shoot tip grafting. This method is still being commercially used by most nurseries to propagate citrus species. Poon (1999) found veneer-grafting of mandarin on trifoliate orange more than 95% success during 2nd to 4th week of December in Dailekh (1300 m) condition. NCDP, Dhankuta studied appropriate date of T-budding in mandarin and sweet orange in 1977 and recommended that the best time for budding of mandarin and sweet orange is 3rd week of May under Dhakuta condition. NCDP (1978) recommended that bare rooted seedlings can be packed with moss and safely kept for 25 days. A model nursery to produce disease–free citrus sapling under insect-proof screen house (10 mess net) condition using inverted T-budding technique was commercially exploited at Banepa by ECARDS (non-government organization) with the support of French Government. Mandarin genotype, J-90 selected by NCRP, Dhankuta was used as mother plant for propagation (Regmi et al., 2008). Shrestha et al. (2011) recorded vigorous growth (84 cm) and stem diameter (7.1 mm) of trifoliate orange seedling in one year of period when grown under poly-house with vermi-compost + soil mixed in 1: 1 ratio.

Niraula and Rajbhandary (1988) developed a protocol for *in vitro* propagation of trifoliate orange rootstock in MS basal medium supplemented with 1 mg/lit BAP and 0.1 mg/lit NAA using cotyledon node as explant. Sweet orange variety Madam Vinous is used as indicator plant for biological indexing of citrus huanglongbing (HLB) disease. Tissue culture protocol was developed for rapid propagation of this cultivar using MS media supplemented with 1 mg/lit BAP and 0.1 mg/lit NAA (Ranjit and Karki, 1999).

Soil and Orchard Management

In Nepal, generally soils are neither tested for nutritional requirements of specific fruit crops, nor are leaf tissues analyzed for mineral contents. NCDP initiated major and micronutrient trials on mandarin at Pokhara and Dhankuta station in 1977. Fertilizer trials in fruit crops are long term nature. But these trials could not continue for longer period and did not produce conclusive results (NCDP, 2046). Baral et al. (2008) reported that majority of the majority of mandarin trees at high altitude orchards of Gorkha, Lamjung and Tanahu districts are deficient in Zn, Ca, Mg and Mn; at mid altitude deficient in Zn, B and Mn and at low citrus growing belts mostly N and Zn were deficient. Based on various literatures NCRP (2014) recommended 300-500 g nitrogen, 200-250 g phosphorous and 250-350 potassium for a bearing mandarin tree to obtain desirable yield. However, to improve the health of severely malnourished full grown mandarin tree the recommendation from NCRP (2014) is FYM 50 kg, N 500 g, P 250 g, K 500 g, Boric acid 20 g, Zinc sulphate 150 g and copper sulphate 75 g to be applied in the ring around the tree canopy.

Tripathi and Dhakal (2005) suggested soil drenching of Paclobutazol (25%) @ 5 ml per tree at the collar region of the tree during July to induce early (4^{th} week of December) in acid lime which is 70 days ahead of normal flowering date under Chitawan condition. Vascular-arbuscular mycorrhiza (VAM) is formed by the symbiotic association between certain Phycomycetous fungi and angiosperm roots. From a study of mycorrhizal status of citrus in Baitadi district, Khadgi (2011) reported 27-92% mandarin root colonized by VAM fungi; roots that were colonized higher percentage by VAM were healthier.

Disease Management

Citrus diseases that are commonly prevalent in Nepal are powdery mildew, wither tip/Anthracnose, damping-off, root rot, foot rot, Gummosis (Phytophthora spp,), pink disease, citrus canker, sooty mould, citrus greening, green/blue mould, citrus scab and tristeza virus (NCDP, 2071). In a generic pest risk analysis (PRA) of citrus, Mahato (2008) recorded 30 pathogens including 24 fungi, 4 bacteria and 2 viruses in Nepal and classified six diseases/pathogens as quarantine pests with high alert, 25 significant and 13 non-significant while 8 having no detail information.

Huanglongbing (Greening) disease is one of the serious problems for citrus fruit production in the world including Nepal. Mass citrus decline was reported for the first time in Pokhara valley by FAO expert Thrower (1968). Later, Knorr et al. (1970) confirmed using thin-layer chromatography that the disease was greening. They also suggested that the disease was introduced from Saharanpur, India with the planting material. Regmi (1982) and Regmi et al. (1996) reported more than 50% greening infested trees in Pokhara valley and up to 100 % in Horticulture Research Station, Malepatan, Pokhara. Further studies confirmed that citrus decline in Kaski, Lamjung, Gorkha, Syangja and Tanahu is mainly due to Huanglongbing (Regmi et al., 2010). The disease is spreading very fast completely destroying healthy and well managed orchards within 6-7 years after infection (Regmi et al., 2009). Bove (2006) and Roistacher (1996) have confirmed that HLB is the major cause of citrus decline in Nepal and cautioned that "Greening will destroy citrus industry in Nepal slowly but surely if necessary measures are not taken in time". They recommended implementation of **Certification Programme** in Nepal.

Nepal Academy Science and Technology (NAST) has been a leading organization to conduct HLB research in Nepal since 1985. Major works undertaken by NAST HLB management include standardized *in vitro* shoot tip grafting (STG) method in Nepal, adoption of DNA probes technique for diagnosis of CGD, development PCR facilities for the rapid diagnosis of HLB, survey and identification of main endemic centres of HLB and study on life cycle and population dynamics of citrus psylla.

Citrus canker disease caused by the bacterium *Xanthomonas citri*, is another important disease of citrus particularly in acid lime. Dhakal et al. (2008) recommended spraying of Boareaux mixture at very early stage of first symptoms appearance to control the disease to a minimum level. Earlier, spraying of Karathane and Kalixin was recommended to control powdery mildew (NCDP, 1978). NCRP (2013) recommended cheaper fungicide such as Insuf or Sulfex (sulphur containing fungicides) to control this disease. NCRP (2013) has also recommended spraying Anti-rot @ 10 ml/l water at 15 days interval during Magh to Falgun and Jestha to Bhadra for the control of gummosis and root/foot disease caused by *phytophthora spp*.

Insect Management

Blue beetle, black aphid, brown aphid, red mites, lemon butterfly, stem borer, bark eating caterpillar green stink bug, Chinese fruit fly, oriental fruit fly, citrus psylla, leaf minors, whiteflies and scale insects are common citrus insect pests in Nepal. Research activities initiated after the establishment of NCDP at Dhankuta on insect management include (i) insecticide trial on black scale insects (ii) insecticidal trial on leaf minor and (iii) fruit fly control program in Bhojpur district. Regular spray of insecticides like Metacid, Folithion and Metasystocks was recommended for the control of black scale (NCDP, 1978). Recently, NCRP (2013) has recommended that spray of mineral oil (Servo Agro-spray or ATSO) @ 20 ml + 2 ml Rogor/l of water during Falgun and Asar is more effective to control most scale insects of citrus fruit crops. In case of leaf minor, recommendation of NCDP (1978) was use of Metasystock @ 0.05% active ingredient followed by Rogor E 25 @ 0.05% active ingredient.

Fruit flies have been a serious problem in many citrus growing areas of the world. In Nepal, the problem of fruit fly was first reported by Mrs. R. B. Pradhan in 2039 BS. In 2043, Mr. Ram Badal Sah estimated the economic loss caused by the insect in Bhojpur district (NCDP, 2047). The farmers brought the problem into notice of the Royal Camp, Dhankuta

(Regional visit of king, Birendra) in 2044. On the directive of Ministry of Agriculture, National Agriculture Research and Service Centre sent a joint team of expert from NCDP, Dhankuta and Entomology Division, Khumaltarin in Asar 2045 to conduct survey and initiate action research to control the insect (NCDP, 1978). The team conducted survey in Sidhdeswor, Gupteswor, Tima, Chhinamakhu, Annapurna and Khawa VDCs of Bhojpur district and noted that 75-90% of citrus fruits were damaged by fruit flies at that time; sweet orange, sour orange, citron and hill lemon most affected while lime and mandarin were least affected. Following the survey and loss assessment, a 3-year (2045/46-2047/48) action research was initiated in above mentioned VDCs for further study and technology demonstration. It was claimed that after one year of treatment application (see below) farmers of study area were able to harvest and sell at least 70% of sweet orange. However, the authors could not find the complete report of this study in the literatures. The package of control measures used in this demonstration (NCDP, 2047) was:

- Treatment of soil with BHC 5% dust @ 50 kg/ha in Aswin-Kartik to kill the maggots and new pupa in soil.
- Collection and disposing of the infected and dropped fruits into 3 feet deep pit during Aswin-Mangsir.
- Use of Pheromone traps (ethyl euginol) to trap and kill the male flies.
- Poising baiting to control adult fruit flies during Chaitra-Aswin
- Regular spray of insecticides during active period (Jestha-Bhadra) avoiding the blooming period.

Above mentioned strategy was employed in citrus research farm, Dhankuta for more than decades. Likewise, District Agriculture Offices launched fruit flies control campaign in eastern hill districts for several years using the male annihilation (through methyl eugenol) and field sanitation tactic. Despite of all these efforts the intensity of fruit damaged by fruit flies did not decrease in eastern hills. In later years, the insect was also reported from other parts of the country. The feromone - methyl eugenol is used to attract and kill male flies of *Bactocera dorsalis* (Oriental fruit fly). In addition to oriental fruit flies, citrus fruits are also affected by Mexican, Mediterian and Chinese citrus fly and management strategy varies depending upon the species affecting the fruit. Therefore, NCRP, Dhankuta hypothesized that fruit flies affecting citrus fruits in eastern hills may not be oriental fruit fly but could be some other species; thus the above-mentioned management technique NCDP (2047) may not has worked. With this hypothesis NCRP, Dhankuta initiated a research work to identify the species and develop management techniques accordingly. Initial achievements of the research are as follows (NCRP, 2013, NCRP, 2014):

Dr. Krishna P. Paudyal (the then Coordinator of NCRP, Dhankuta) reared adult flies from the maggots of affected sweet orange fruits for identification of species in 2007. The reared flies were much bigger than *Batrocera dorsalis* (captured in methyl eugenol).

First of all Dr. Paudyal tried to identify reared species by comparing it with reference photographs (Reference: Fruit Flies of Economic Significance, their Identification and Bionomics by Ian M. White and Marlene M. Elson-Herris; publisher–CAB International). The description and the reference photograph indicated that the fruit flies affecting citrus fruits in eastern hills could be Chinese citrus fly (*Bactocera minax*).

The reared adult fly samples were also sent Entomology Division, Khumaltar for species identification and conservation. The scientists at Entomology Division confirmed that it is not *Batrocera dorsalis*. So, 16 samples reared and collected on 27thApril 2007 by Dr. Paudyal were sent to The Museum of Entomology, Florida State Collection of Anthropods for identification on 30thApril 2007 with the help of Entomology Division and Dr. Ken Sorensen, Professor, North Carolina State University. Dr. Gray J Steek, Curator of Diptera, Florida State Collection of Anthropods identified the specimens of flies as *Bactocera* (Tetradacua) *minax* (Enderlein) and reported it to Nepal on 26th Sept. 2007 confirming that the fruit fly species affecting citrus fruit in Dhankuta is not oriental fruit fly (*Batrocera dorsalis*) but it is Chinese citrus fly (*Bactocera minax*).

NCRP, Dhankuta continuously collected affected fruit samples (sweet orange, hill lemon and mandarin) from Dhankuta, Terathum, Bhojpur, Parbat, Myagdi, Gulmi and Ramechhap districts. All the adults emerged from these samples were found *Bactocera minax* upon comparison with reference samples.

Upon identification of appropriate species of fruit fly affecting citrus in Nepal as *Bactocera minax* further studies on (i) identification of oviposition period and (ii) assessment of attractiveness of lures for the species were initiated at NCRP, Dhankuta (NCRP, 2012, 2013 and 2014). The studies showed that (i) maximum infestation (89%) is on second week of Jestha followed by next two fortnights (ii) the oviposition period *Bactocera minax* is between 15th Jestha to 15th Asar suggesting that control measures during this period should be employed for minimizing the population of the species (iii) maximum pupal emergence from infested fruit occurs on 7th day onward after fruit dropout. (iv) Australian fruit fly lure (autolyzed protein) @ 50 ml/l was found more effective lure to attract *Bactocera minax*. The studies are on-going in NCRP, Dhankuta.

Green stink bug (*Rynchocoris humeralis)* is another insect that causes fruit drop in citrus. Pandey and Rana (1992) studied the magnitude of fruit drop caused by the bug in mandarin and the parasites associated with it at farmers' orchards in Tanahu district. Mandarin fruits were more susceptible to damage in early growth stage of the crop. About 50% pre-matured fruit drop was caused by this bug in the month of August and September. They recorded natural parasitiode of the bug in mandarin orchards and out of 365 eggs of *R. humeralis* incubated, 23 (6.3%) were parasitized by the parasitoide, 135 (37%) hatched and 207 (57.7%) did not hatch. NCRP (2013) has recommended spraying of contact + systemic insecticide (Rogor @ 1 ml + Doom 1 ml/l of water) at the nymph stage of the bug (white to yellow color) in the month of Jestha to Bhadra in 15 days of interval to control this insect. Citrus psylla (*Diaphorina citri*) is the insect vector of *Candida liberibacto*r bacteria that causes citrus greening disease. Regmi and Lama (1988a and 1988b) studies biology, range of host plants and natural enemies of citrus psylla in Pokhara Valley during 1985-1989.

Post-harvest

NCDP had initiated studies on storage of mandarin and sweet orange under cellar store condition at Agriculture Research Station, Dhankuta in late 1980s. Storage of mandarin in perforated polythene bag was recommended from the study (DAS, 2046). Gautam and Adhikari (1989) reported that mandarin fruits either stored in sand or husk, both in pit or room are better in overall quality as loss of luster and shriveling are reduced in such storage. Thapa and Shrestha (2000) suggested grading of mandarin fruits based on diameter into extra-large (68-77 mm), large (60-66 mm), medium (55-62 mm) and small (51-56 mm). Based on various studies on harvesting, packaging and storage of mandarin, Bhusal (2002) recommended that fruits harvested by clipping by scissors at 26-50% yellow color stage to store in underground cellar storage for 3 months. Transportation loss in plastic crates is only 1% compared to 15% in truck (Dhala) and decay loss in storage is more than twice in Dhala transported fruits. Treating with Bevistin 0.1% as well as Bevistin 0.1% + wax 10% are most effective ways to control decay of the fruits in storage (Bhusal, 2002). Paudel et al. (2004) recommended modifies cellar storage with precooling chamber to store mandarin fruits up to 120 days treated with garlic extract solution. Bastakoti and Gautam (2007) also conducted storage studies mandarin in modified cellar stare. They noted that different maturity stages influenced the storability and quality of mandarin fruits. The fruits harvested at 26-50% yellow stage had minimum weight loss and rotting percentage along with good taste, freshness, firmness and higher degree of overall acceptability after the storage of 105 days (Bhusal et al, 2007). Dipping the fruit in wax (10%) emulsion minimizes weight loss and dipping waxed fruit in Bebomyl (0.1%) reduces rotting percentage (Bastakoti and Gautam, 2007). Some of the citrus varieties attain internal maturity while peel color is green. Guatam et al. (2004) recommended dipping fruits in 100-200 ppm ethylene solution to develop yellow color in the peel of mandarin.

Socio-economic and Marketing

Citrus fruit crops in the hills of Nepal are considered as one of the remunerative production options because of its agro-ecological suitability in fragile and marginal hill-slopes and high value nature. Various studies have been conducted on marketing aspects of citrus fruits. Shrestha and Shrestha (2000) characterized the mandarin marketing system of Nepal as (i) rudimentary in nature (ii) season glut and chaotic in market price (iii) lack of specialized marketing function (iv) small scale and scattered production and (v) lack of appropriate post-harvest technologies, transportation facilities and market facilities. There are various technological, socioeconomic, institutional and policy constraints providing hindrance to smooth adoption, commercialization and sustainability of citrus farming in the hills (Gauchan, 2000). The marketing problems include low price of the produce, lack of transportation facilities, problems in selling, unorganized nature of market, monopoly of contractor and lack of storage and processing facilities. Bloom and fruit drop due to long spell drought and strong hailstorm during flowering and fruiting season as well as citrus green stink bug, shoot borer, leaf minor, lemon butterfly and citrus aphids, canker, gummosis and tristeza virus are the major problems of lime/ lemons (Dhakal, et al, 2002).

In western hills, pre-harvest orchard contract to both local and nonlocal contractor is pre-dominated mode of mandarin selling through verbal contract with lump sum advance money or without receiving advance money from the third week of August to first week of January (Gurung, 2001). The farmers' choice to choose contract mode of selling is affected by the number of fruiting trees, age of the orchard, location, category of farmers, maturity stage of the fruits and buying agents. The farm gate price of mandarin is affected by last year's price, bargaining capacity of the farmers, location, and ethnicity of farmer, mode of selling and category of the farmers. The farmers who sell by contract system generally get fewer prices than in non-contract system selling. There is also a distinct seasonal variation in the price of mandarin (Gurung, 2001). Since there are different marketing channels for different livelihood status farmers available of technology, produce market, infrastructures and facilities are not the sufficient conditions for inclusive citrus development in Nepalese hill context; the necessary conditions are appropriate institutional rules, laws and policies that can ensure access of rural marginal farmers to marketing of high value commodities like mandarin (Ghimire, 2010).

In some parts of the country such as in the hilly area of Chitawan district farmers strongly believe that requirement of fruit trees are not so different from that of forest species. Therefore overall management of mandarin orchards has been left on the nature with minimum intervention from growers (Pant, 2001). Khoku village of Dhankuta district is very famous for high quality mandarin production in Nepal. In this village, about 32% of the total annual income is contributed by mandarin. In this village anual income from the sale of mandarin ranges from NRs 30,000 to 250,000. Except sulphur spraying cost no external inputs are used to produce mandarin in this VDC (Gautam et al., 2011).

After mandarin and sweet orange, lime is third important citrus commodity in Nepal used for fresh salad, juice, and processed products such as juice, squash, *chuk* and pickle. Dhakal et al., (2002) conducted a survey on lime and lemon cultivation system in Nepal. The survey showed that average size of holdings for lime and lemon was 45 trees/orchard, dominated by local land races, maximum production 235 (lime) and 147 (lemon) kg per tree per year in 2001. Annual commercial consumption of lime in 14 major cities of Nepal was 2,327 ton of which 85 percent was consumed in Kathmandu valley in 2001 (Dhakal et al. 2005). More than 90 % (2108 ton; valued Rs 50.4 million) was imported from India and only 5.5 percent was from domestic lime. Despite of several R and D efforts like 'Lime Mission' undertaken by the government the situation has not changed even after a decades. The recent data from Kalimati Fruits and Vegetables Whole Sale Market Development Board shows that 98.4 percent (2,340 t) of the lime supplied from Kalimati Market in 2014 (2071 BS) was from in India.

IMPORT AND EXPORT

As described in above sections, systematic citrus development was initiated by the government since 1960s. Research stations were established for technology generation. Extension and other services including subsidies are being provided through District Agriculture Offices. Government's policies and periodic plans have given due priority to citrus fruit crops. In fact, it is number one priority fruit crop of Nepal. From time to time donor supported special projects are also implemented for R and D of citrus fruit crops. Because of such efforts production of citrus fruit crops is increasing over the years (Table 3). But production increase in citrus fruit crops is due to area expansion. Productivity is either stagnant or decreasing in recent years. It indicates that improved technologies are not properly used in production system. The domestic production is not sufficient to meet growing market demands of the country. The country's dependency on imported citrus fruit crops particularly in lime (Kagati) and sweet orange (Junar) is above 80 percent. Import of mandarin (Suntala) is also increasing at alarming rate (Table 7 and 8).

Table 7. Trade situation of citrus fruit crops in Nepal

Year	Export (Rs)	Import (Rs)	Trade deficit
2010/11	427,373	54,975,348	(54,547,975)
2011/12	299,329	303,758,177	(303,458,848)
2012/13	5,454,189	358,733,525	(353,279,336)
2013/14	3,429,523	550,285,188	(546,855,665)

Source: MoAD, 2011, 2012, 2013 and 2014.

Table 8. Proportion of imported citrus fruits distributed from Kalimati Wholesale Fruit and Vegetable Market, Kathmandu.

Nepali Year	Lime		Mandarin		Sweet Orange		Lemon		Sweet Lime		Kinnow	
	Total trade (mt)	Share of import (%)	Total trade (mt)	Share of import (%)	Total trade (mt)	Share of import (%)	Total trade (mt)	Share of import (%)	Total trade (mt)	Share of import (%)	Total trade (mt)	Share of import (%)
2060	1863	98.1	5111	7.2	89.3	72.8	14.6	0.0	2.7	0.0	12.2	100.0
2061	2520	99.9	3689	1.3	165.7	79.7	16.7	0.0	32.8	0.0	25.3	100.0
2062	1973	99.4	3422	5.8	270.9	86.8	7.3	0.0	4.2	0.0	47.2	100.0
2063	1592	99.5	4874	12.9	396.5	93.1	78.2	34.4	52.8	0.0	31.2	100.0
2064	1591	98.4	6271	8.6	466.1	91.0	10.6	0.0	17.8	0.0	68.3	100.0
2065	1650	98.4	4660	29.4	273.0	71.9	17.5	68.6	4.5	0.0	0.0	0.0
2066	1526	95.9	4801	48.6	294.2	75.2	3.0	0.0	4.0	0.0	1.3	100.0
2067	1753	99.3	14580	27.3	355.0	73.5	16.0	0.0	5.5	0.0	1.4	100.0
2068	2004	99.3	13230	15.0	538.9	97.7	21.0	0.0	91.0	0.0	24.0	100.0
2069	1854	96.7	11891	19.6	475.2	74.1	42.1	52.3	15.0	0.0	22.9	100.0
2070	2431	99.3	8235	19.3	595.2	74.5	13.7	0.0	18.0	0.0	10.0	100.0
2071	2340	98.4	6540	23.4	222.7	94.7	18.0	16.7	1.5	0.0	107.6	100.0
Mean	1924	98.6	7275	18.2	345.2	82.1	21.6	14.3	20.8	0.0	29.3	91.7

Source: Yearly Report of Kalimati Fruit and Vegetable Whole Sale Market.

REFERENCES

Baral. D.R., D.D. Dhankal, G.K. Shrestha and SC Jha. 2008. Foliar nutritional level of mandarin orchards at different altitude, age and health in mid-hills of Nepal. Proceedings of the 5th National Conference on Science and Technology, Nov 10-12, 2008, Kathmandu, Nepal Academy of Science and Technology.

Bastakoti, B. and D.M. Gautam. 2007. Effect of maturity stage and post-harvest treatments on self-life and quality of mandarin oranges in modified cellar store. J. Inst. Agric. Anim. Sci. Vol. 28.

Bhusal, Y.R., D.M. Gautam, D.D. Dhakal and P.P. Subedi. 2007. Effect of maturity stages on post-harvest self-life and quality of mandarin orange. IAAS Research Advances Vol. 1, 2007, Institute of Agriculture and Animal Sciences, Rampur, Chitawan.

Bhusal, Y,R. 2002. Improvement of post-harvest self-life of mandarin orange (*Citrus reticulata*). M. Sc. Thesis, Department of Horticulture, IAAS Rampur, Chitawan, Nepal.

Bove, J.M., 2006. Huanglongbing: a destructive, newly emerging, century old disease of citrus. Journal of Plant Pathology, 88 (1), 7-37

Chalise, B., R. L. Shrestha, K.P. Paudyal, H.P. Subedi and S.P. Srivastava. 2011. Effect of different doses of GA_3 and nitrogen under open and plastic tunnel condition on trifoliate orange seedling growth. Proceedings of the Seventh National Horticulture Workshop, June 12-14, 2011, Nepal Agriculture Research Council and Nepal Horticulture Society.

DAS. 2046 B.S. Research Report, 2045/46 (1988/89). Dhankuta Agriculture Centre.

Dhakal, D., C. Regmi and S.R. Basnyat. 2008. Etiology and control of citrus canker disease in Kavre, Nepal. Proceedings of the 5th National Conference on Science and Technology, Nov 10-12, 2008, Nepal Academy of Science and Technology.

Dhakal, D.D., K.M. Tripathi and S Bhattarai. 2005. Marketing survey of lime and lemon production in Nepal. J. Inst. Agric. Anim. Sci. Vol. 26.

Dhakal, D.D., T. P. Gotame, S Bhattarai and HN Bhandari. 2002. Assessment of lime and lemon production in Nepal. J. Inst. Agric. Anim. Sci. Vol. 23.

Dhakal, D. D. 2008. Assessment of production and marketing of lime in hills of Nepal. J. Inst. Agric. Anim. Sci. Vol. 29.

Gauchan, D. 2000. Economics and sustainability of citrus farming in Nepal: A case study of mid-hills. Proceedings of the 3rd National Horticulture Research Workshop, 7-8 June, 2000, Khumaltar, Nepal Agricultural Research Council.

Gautam, D.M. and R. R. Adhikari. 1989. Study on modified local methods of orange (*Citrus reticulata*) storage. J. Inst. Agric. Anim. Sci. Vol. 10.

Gautam, I. P., K. B. Paudel and K. P. Upadhyay. 2004. De-greening of

mandarin orange for early market in the hills of Nepal. Proceedings of 4th National Conference on Science and Technology, March 23-26, 2004, Nepal Academy of Science and Technology.
Gautam, S., S. Amatya, B. Sharma, M. B. Nepali and S. Srivastav. 2011. Contribution of mandarin in household income and livelihood of mandarin growers in the eastern hills of Nepal: A case study of Khoku VDC, Dhankuta district. Proceedings of the 7th National Horticulture Seminar, June 12-14, 2011. Nepal Agricultural Research Council and Nepal Horticulture Society.
Ghimire, Y.N. 2010. Access of rural hill farmers of Nepal to agriculture marketing of high value crops: Implication for poverty reduction. Proceedings of the 9th Outreach Research Workshop, June-7-8, 2010, Khumaltar, Lalitpur, Nepal Agricultural Research Council.
Gotame, T.P., K. P. Paudyal and P.P. Khatiwada. 2014. Status of Fruits and Genetic Resources in Nepal. Horticulture Research Division, Nepal Agricultural Research Council.
Gurung, C.B., 2001. Marketing of mandarin orange (Citrus reticulate) in western hills of Nepal: Analysis of price behavior and contractual arrangement. M. Sc. Thesis, Department of Agri. Economics, IAAS, Rampur, Chitawan, Nepal.
HARP. 2001. Profiles of Hill Research Programme Funded Projects in Nepal. Hill Agriculture Research Project (HARP).
HARP. 2004. Summary of HRP Projects Completion reports, Volume II. Hill Agriculture Research Project.
HDP. 1995. Annual Report 1994/95. Horticulture Development Project Phase II, Kirtipur, Nepal.
Hockey, H., U.L. Chaudhary and M.S. Ghale. 1996. Comparison of seven provenances of mandarin orange using graphical and cluster analysis techniques Proceedings of the First National Horticulture Research Workshop, 1-2 May, 1996, Nepal Agricultural Research Council.
Khadgi, B.R. 2011. Study on Mycorrhizal status of citrus in Baitadi. Proceedings of the Seventh National Horticulture Seminar, June 12-14, 2011, Nepal Agricultural Research Council and Nepal Horticulture Society.
Knorr, L.C., S. M. Sah and O.P. Gupta. 1970. Greening Disease of Citrus

in Nepal. Plant Disease Reporter. 54: 1092-1095

Lama, T.K, N.P. Ghimire and C.M. Baral. 1984. Research note on performance of some selected cultivars of citrus at Pokhara. Journal of Institute of Agriculture and Animal Science: 5

Lohar, D. and T.K. Lama. 1997. Status Report on genetic resources of citrus in Nepal. IPGRI Project No. B06. IPGRI Regional Office for Asia and Oceania, Malaysia.

Mahato, B. N. 2008. Generic pest analysis (PRA) of citrus. Proceedings of the 5th National Conference on Science and Technology, Nov 10-12, 2008, Nepal Academy of Science and Technology.

MoAD. 2011-14. Statistical information of Nepalese Agriculture, 2010/11, 2011/12, 2012/13, 2013/14. Ministry of Agriculture Development, Government of Nepal.

NARDF. 2008 and 2010. Project Completion Reports of 2008 and 2010. National Agricultural Research and Development Fund.

NCDP. 1978. Report 1975/76-1977/78 (2032/33-2034-35). National Citrus Development Program, Dhankuta, Nepal.

NCDP. 2046 (1989). Report Sixth Five Year Plan 1980/81-1984/85 (2037/38-2041/42). National Citrus Development Program, Dhankuta.

NCDP. 2047 (1990). Report: Seventh Five Year Plan – 185/86-1989/90 (2042/43-2046/47). National Citrus Development Program, Dhankuta.

NCDP. 2071. Annual Report (in Nepali). Narional Citrus Development Program, Kirtipur, Nepal.

NCRP. 2013 and 2014. Annual Report 2069/70 (2012/13) and 2070/71 (2013/14). National Citrus Research Program, Paripatle, Dhankuta.

Niraula, R. and S. B. Rajbhandari. 1988. In vitro propagation of trifoliate orange (Poncirus trifoliate). Proceedings of the National Conference on Science and Technology, April 24-29, 1988, Royal Nepal Academy of Science and Technology.

Pahari, S. and H.P. Bimba. 2004. Assessment of genetic diversity of Citrus reticulata Blanco and Citrus limon (L.) Burn F. of Nepal through isozyme analysis. Proceedings of 4th National Conference on Science and Technology, March 23-26, 2004, Nepal Academy of

Science and Technology.

Pandey, R.R. and R.B. Rana. 1992. Green stink bud (Rynchocorishumeralis) damage of mandarin fruits and its natural parasitisation by Trissolcus sp. J. Inst. Agric. Anim. Sci. Vol 13.

Pant L.P. 2001. Local knowledge about management of mandarin orchards in Chitawan hills of Nepal. J. Inst. Agric. Anim. Sci. Vol. 21-22.

Paudel, K.B., H.N. Regmi, I.P. Gautam, J.N. Chaudhary, K.P. Upadhya, D. Pokharel and B. Khatri. 2004. Modified cellar store: An efficient and economically sustainable means for storage of mandarins in Nepal. Proceedings of 4th National Conference on Science and Technology, March 23-26, 2004, Nepal Academy of Science and Technology.

Paudyal. K.P. and B. Chalise. 2007. Evaluation of Satsuma mandarin (Citrus unshiu) for early season production in Nepal. Proceedings of the Fourth National Horticulture Seminar, January 18-19, 2007, Nepal Horticulture Society.

Paudyal, K.P. and H. Subedi. 2008. Selection of sweet orange (Citrus sinensis Osbeck) varieties for production period expansion. Nepalese Horticulture: 6, Nepal Horticulture Society.

Paudyal, K.P., H. Subedi and B. Chalise. 2011. Selection of elite mandarin (Citrus reticulata Blanco) mother plants from local genotypes. Proceedings of the 7th National Horticulture Research Workshop, 12-14, June, 2011, Khumaltar. Nepal Agricultural Research Council.

Paudyal, K.P. 2000. Farmers' participatory selection of superior pummelo (Citrus grandis L. Osbeck) trees in Nepal. Proceedings of the Third National Horticulture Research Workshop, 7-8 June. Khumaltar, Nepal Agricultural Research Council.

Poon, T.B. 1999. Effect of grafting methods and time on mandarin sapling production at Dailekh. Proceedings of the Second National Seminar on Horticulture Research, June 1999. Nepal Agriculture Research Council.

Ranjit, M. and A. Karki. 1999. In vitro propagation of sweet orange (Citrus sinesis L. Osbeck) cv. Madame Venous for production of disease-free indicator plants against citrus disease. Proceedings of

III National Conference on Science and Technology, Volume II, March 8-11, 1999, Royal Nepal Academy of Science and Technology.
Regmi, C. and T.K. Lama. 1988 a. Greening incidence and greening vector population in Pokhara. Proc 10th Conf. IOCV, IOCV, Riversie. pp. 238-242.
Regmi, C. and T.K. Lama. 1988 b. Range of host plants of DiaphorinacitriKuw – a vector of citrus greening disease. Proc. Nat. Cong. Sc. and Tech, RONAST, pp. 158-160
Regmi, C, I.P. Kafle, K.P. Paudyal, G. Aryal and G. Awasti. 2008. Screen house system to produce quality planting materials of citrus in Banepa. Proceedings of the Fifth National Seminar on Horticulture Research, June 9-10, 2008, Nepal Academy of Science and Technology, Nepal Agriculture Research Council and Nepal Horticulture Society.
Regmi, C., R.P. Devkota, K.P. Paudyal, S. Shrestha, A.J. Ayres, N. Murcia, J.M .Bove and Duran-Vila. 2010. Shifting from seedling mandarin trees to grafted trees and controlling Huanglongbing and viroids; a Biotechnological Revolution in Nepal. In Proc.17th IOCV Conf. IOCV Riverside. p. 116 -122.
Regmi, C, M. Garnier and J.M. Bove.1996. Detection of the Asian Huanglongbing (Greening) Liberobactor in Nepal by DNA - DNA. Hybridization Proc. XIII Conf. IOCV, IOCV, Riverside. p. 267-270.
Regmi, C., 1982. Mycoplasmlike diseases of citrus in Nepal and USSR (spread, effect aetology, varietal resistance, possible vectors) Ph.D. dissertation. MoscowAgricultureal Academy, Moscow. pp. 144.
Roistacher, C.N. 1996. Assessment of the greening problem, the severity and prevalence of virus and virus-like diseases and development of an appropriate set of procedures for a citrus certification program for Nepal. A consultancy report, ATSP, Kathmandu.
Shrestha, B. and R.L. Shrestha. 2000. Marketing of mandarin orange in the western hills of Nepal: Constraints and potential. Proceedings of the 3rd National Horticulture Research Workshop, 7-8 June, 2000, Khumaltar, Nepal Agricultural Research Council.
Shrestha. P.P. and S.K. Verma. 1998. Development and outlook of citrus industry in Nepal. Proceedings of the National Horticulture

Workshop, January 19-21, 1998, Kirtipur, Kathmandu. Nepal Horticulture Society.

Shrestha, R.L. and K.P. Paudyal. 2004. Proceedings of the Fourth National Horticulture Research Workshop, March 2-4, 2004, Nepal Agricultural Research Council.

Shrestha, R.L, K.P. Paudyal, B. Chalise, H.P. Subedi and J.L. Mandal. 2011. Growth of trifoliate orange seedlings at different management conditions in NCRP, Dhankuta. Proceedings of the Seventh National Horticulture Workshop, June 12-14, 2011, Nepal Agriculture Research Council and Nepal Horticulture Society.

Thapa, M.B. and Shrestha, M. B. 2000. Study on grading, packaging and transportation of mandarin orange. Proceedings of the Third National Horticultural Research Workshop, 7-8 June, 2000, Nepal Agricultural Research Council.

Thrower, L. B. 1968. Report on visit to Nepal. FAO Report PL: T51

Trpathi, K. M. and D.D. Dhakal. 2005. Effect of paclobutazol on off-season flower induction in acid lime land races under Chitawan condition. Journal of the Institute and Animal Science, Vol. 26.

STATUS AND PROSPECTS OF POTATO RESEARCH AND DEVELOPMENT IN NEPAL

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ABSTRACT

Potato is an important crop of Nepal. Due to its short vegetative cycle and high cash value, it plays an important role in country's food production and poverty reduction. Despite its significance in food security and cash generation, the average productivity is one of the lowest in the world. Lack of appropriate production technologies in the country and use of inferior seed tubers by majority of the farmers are identified as two of the major limiting factors. With the objectives of generating suitable and stable appropriate technologies and disseminate them to increase the production and productivity for different agro-ecological zones of the country through coordinated research approach, National Potato Research Programme (NPRP) and National Potato Development Programme (NPDP) are in function with the RandD mandates in the country on potato crop. Since the establishment of these two programmes, tremendous progresses have been made. However, the productivity of this crop is far below its potentiality compared to the neighboring countries and even world average. This paper reviews the present status potato RandD of Nepal and attempts to assess its prospects.

INTRODUCTION

Potato is one of the most important crops in Nepal used as a major vegetable crop in mid-hills and terai where as it is one of the staple food crops in high hills. Regarding the scope of this crop, it occupies the fifth position in area coverage, fourth in total production and first in the productivity as compared with the main staple food crops, rice, maize, wheat and millet (Fig. 1). Nevertheless, potato contributes its roles in cash generation and food production per unit area for small holder farmers. With the goal of improving livelihoods of Nepalese farmers through this crop, two different national level RandD programmes namely National Potato Research Programme (NPRP) and National

Potato Development Programme (NPDP) were established in the country. Since then, tremendous progresses have been made in potato research and development in Nepal, which has been mainly because of excellent efforts of these programmes and of course above all untiring efforts of potato farmers and stakeholders.

NPRP conducts experiments within the disciplines of varietal evaluation, disease and pest management, soil fertility improvement, True Potato Seed (TPS) utilization, post-harvest (storage), and value addition of potato and sweet potato crops, whereas NPDP is engaged in technology transfer, capacity building, policy support and overall developmental activities for the promotion of potato industry in the country.

Climatic diversity of the country permits year round cropping of potato from plains (70 m a s l) to the mountains (4400 m a s l). By agro-ecological region, out of the total area under potato crop, around 19% lies in the high hills/mountains, 43% in the mid-hills and remaining 38% in the Terai and Bhabar (Fig. 2). It occupies the fifth position in area coverage, second in total production and first in productivity among the food crops grown in the country (ABSPD, 2014), but still the productivity of this crop is far below to its potentiality.

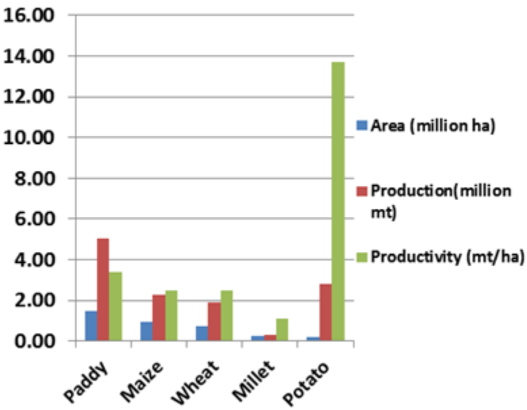

Figure 1. Area production and productivity of major crops in Nepal 2013/14

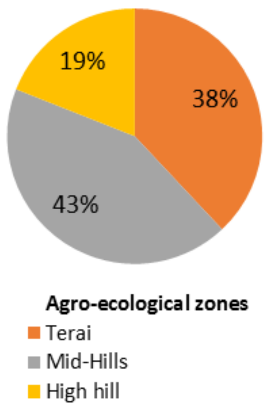

Figure 2. Area coverage under potato crop by agro-ecological zones

Though the introduction of this crop in Nepal is considered shortly after the introduction in Europe, the average yields are still among the lowest in the world (13.6 t/ha). Besides many other reasons, unavailability of seed in terms of desired varieties, quality and quantity with affordable price and low adoption scale of cultivation technologies are the major limiting factors resulting lower yield even though other production inputs are applied at optimal level. There is huge potential of potato crop that could contribute to the national economy within its scope of fresh and processed food demand in the changing socioeconomic contexts. If the problems were managed in an integrated way and yields were improved well, Nepal could benefit its geography being in the middle of two big countries like China in north and India in south.

The first official attempt to improve potato production was initiated in 1962 under a joint programme between Nepal and India. During its earlier phase (1960-75), potato farms and related infrastructures were developed across the country. With the increased importance of potato crop in national food production, National Potato Development Programme (NPDP) was incepted in 1972 at Kirtipur with a nationwide mandate to conduct potato research and development activities. Two potato farms, one at Jaubari, Ilam and another at Nigale, Sindhupalchowk, were established during 1980s. In 1974, NPDP was relocated to Khumaltar and linkages were established with International Potato Center (CIP) Lima, Peru, which is still effective in various aspects.

MAJOR ACHIEVEMENTS

Both the potato programs are working to resolve different problems on potato through different arrangements in RandD activities in the country and some of them are as following.

Varietal improvement

To date, the following potato varieties have been released for different agro-climatic conditions:

Released Varieties	Agro- climatic zones
Kufri Jyoti	High and mid hills
Kufri Sindhuri	Terai and inner Terai
Desiree	Hills and Terai
Janak Dev	High and mid hills
Khumal Rato-2	Terai and inner Terai
Khumal Seto-1	High and mid hills
Khumal Laxmi	Terai to high hills
IPY 8	Terai to mid hills
Khumal Ujjol	Hills
Khumal Upahar	Terai

In addition, two TPS lines namely TPS-1 (HPS II/67) and TPS-2 (HPS 7/67) are officially registered for commercial cultivation in the country.

Technology Development

- Seed tuber treatment and three times foliar spray of Asuro (Justicia adhatoda) and EM mixed suspension at 10 days interval has been effective for increasing tuber yield. Black plastic and paddy straw mulching increase yield under less irrigated and moisture stress condition.
- Improved technologies for potato production (seed selection, planting methods, irrigation methods, fertilizer application, plant protection, seed production and storage) have been developed and recommended.
- Integrated disease management technologies have been recommended to minimize the losses due to major diseases such as late blight, bacterial wilt, and black scurf.
- Screen house has been found more cost effective than glasshouse for pre-basic seed production in the country like Nepal where there are tremendous number of constraints to run sophisticated glasshouses.
- 100,000 to 200,000 virus (PLRV, PVX, PVY, PVS, PVA and PVM) free pre-basic seed potatoes are produced through tissue culture

technology and distributed every year.

- Black polythene mulching and Metribuzin (pre-emergence herbicide) are found highly effective for controlling weeds in potato crop.
- Eight potato cultivars (Cardinal, NPI-106, CIP 388572.1 and CIP 388572.4) have been cleaned for virus free seeds of potatoes. More than 100 local and exotic germplasm are maintained in-vitro for research and production purpose.
- Six major viruses (PLRV, PVX, PVY, PVS, PVA and PVM) free pre-basic seed potatoes are produced through tissue culture technology by NARC and distributed to the seed growers through Department of Agriculture every year.
- In processing part, genotypes PRP 25861.1, Yagana, L-235.4, HPS II/67, NY-123, HPS 7/67, BSU-PtO3, K. Chipsona -2 and Khumal Seto-1 are found promising not only for higher yield but also for processing for chips. The pink-skinned clone named PRP 25861.1 which has high level of late blight disease resistance and high dry matter will be proposed soon for releasing.
- The fertilizer trial conducted on variety Kufri Jyoti showed the highest tuber yield (30.22 t/ha) was obtained in combination of 150 kg N2 and 60 kg K2O/ha.

Increase in Area Coverage Production and Productivity

Potato production has been increased both through the increase in area coverage and productivity (Table 1) driven by development of improved varieties, access to clean seed, enhanced capacity and technology extension. In the year 2012/13, the area under potato was reported to be 197, 234 ha and production of 2,690,421 tons with an average productivity of 13.6 t/ha (MoAD, 2013) and which is about 4.6 percent of total crop area of the country. Increase in area is justified because of its market demand and popularity both due to its food and cash value; and diversity in food recipe. During the last four decades the potato production sifted from remote hills to easy excess areas. It is due to the market demand by urban population. Cropping pattern also changed from traditional seasonal to off-season cultivation. The total production for the year 2013/14 was 2,817,512mt which is nine times higher when we peep back to the production of 307,483mt in 1974/75 (Figure 3). The productivity has been gone up from 5,700 kg to 13,695 Kg/ha respectively during last 4 decades period. Although, average productivity of 13.64mt/ha in Nepal remained behind (FAO, 2014) compared to India (22.76 t/ha), Pakistan (21.80 t/ha), Bangladesh (19.37 t/ha) and Sri Lanka (15.32 t/ha).

NPRP still manages a full-fledged tissue culture laboratory for the pre-basic seed (PBS) potato production. More than 150 genotypes are in-vitro maintained and about 200,000 minitubers of different varieties are produced each year under quarantined glasshouse conditions at Khumaltar and distribute to seed growers through National Potato Development Programme/DOA. PBS is also further multiplied in Horticulture Farms under NARC and DoA for basic seed production to meet the farmer's demand of their respective command areas. In the recent years the private entrepreneurs are also producing in-vitro based PBS in with support from NPDP and NPRP.

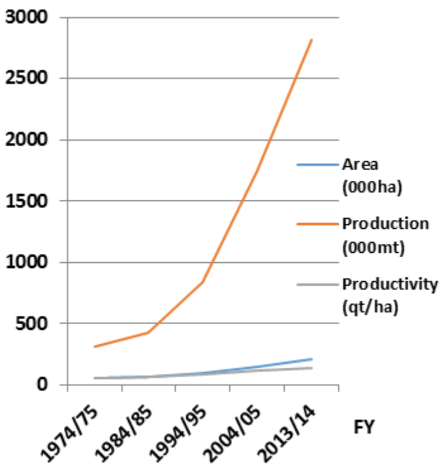

Figure 3. Area, production and yield of potato crop

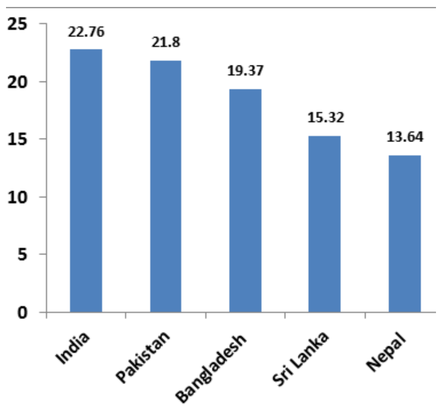

Figure 4. Potato productivity (mt/ha) in SARC countries

Seed System

In 1989, a tissue culture laboratory was established with the financial and technical support of Swiss government and the contract growers were encouraged to form a cohesive group for informal production of high quality seed at that period. Source seed as pre-basic seed is to date being supplied by the tissue culture laboratory.

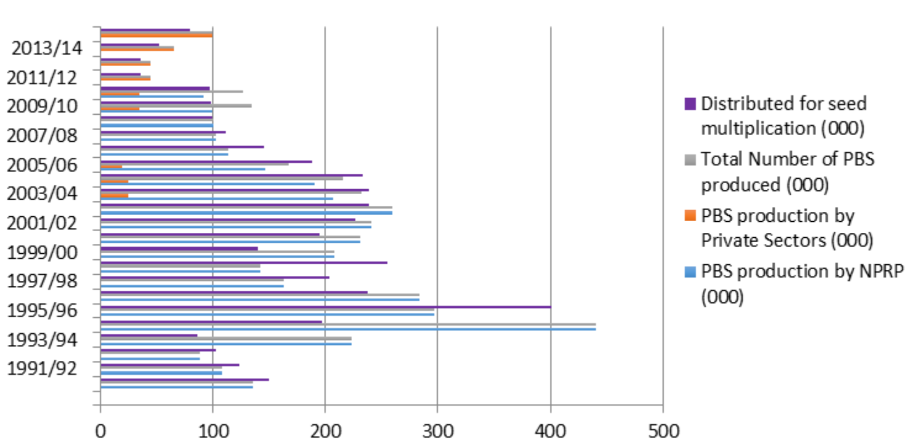

Figure 5. Production and distribution of PBS by private and government sectors from FY 1992/93 to 2013/14

In Nepal, seed production programs are operating in three systems

- Traditional system – The remaining stock of potato after table purpose is being used or marketed as "seed potato" which are mostly small sized (10-15gm) whole tuber.
- Formal system– Seed potato is mainly produced by government farms following specified technical norms, specification, rules and regulations. It is guided by the seed certification rules embedded in the prevailing "Seed Act".
- Seed producer group (SPG) approach– A group of trained and well experienced potato farmers are engaged in seed production program through a formal group. The seed production program is technically supported by designated technicians throughout the crop season including post-harvest management. Recently, visualizing the scope

and demand of seed potato in the country the government has decided to produce clean seed potato by using such farmers' group within the broader umbrella of seed act. A self-sufficiency seed potato program has been launched since 2010 reaching 38 districts in current year 2015. These groups are empowered to produce quality seed which is certified by the Seed Quality Control Centre (SQCC) under MoAD, Regional Laboratories and trained seed inspectors.

Above model of on-farm informal seed production through SPG approach has been well documented and accepted by MoAD to further scale-up to the semi-formal seed potato production program in the country.

Utilization of True Potato Seed (TPS) for Seed and Ware Potato Production

Production of seedling tuber as a quality seed material by sowing TPS in nursery bed and seedling transplanting for ware potato production are two major methods of TPS utilization in Nepal. TPS is an alternative low cost technologies especially for those areas where bulky seed tuber becomes expensive and either not available on time. Transfer of TPS technology to Nepalese farmers, for the first time was initiated during 1993-94 season designing a "Technology Verification Demonstration" approach (Lama, 2001). Farmers' acceptance of the technology resulted initiation of seeding tuber production (first tuber generation from TPS) to fill the gap of seed potato requirement in specific environment of its potentialities.

To fulfil the growing TPS demand both government and private sectors are engaged in production of TPS in the country. Average TPS utilization in Nepal is about 50 kg per annum.

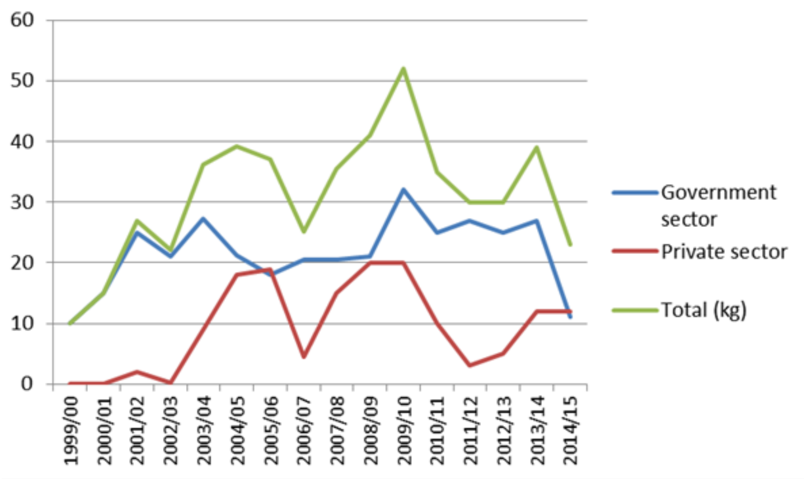

Figure 6. Production of TPS by private and government sectors

Integrated Disease Management (IDM) of Potato through Farmers Field School (FFS)

In 1999/2000, NPDP in collaboration with CIP and Users' Perspective with Agricultural Research and Development (UPWARD) initiated IDM practice on potato through FFS approach simply to enhance farmer's decision making capacity in utilizing their resources judiciously making potato farming as a profitable enterprise (PDS, 2001).

Integrated Diseases management (IDM)practice is driven by FFS approach which is one of the recent participatory RandD methods benefiting farmers "doing better science together". This approach is a new dimension for enhancing farmers' capacity to understand the agro-ecosystem to apply appropriate management practices through informed decision making process. Basic principle of these approaches is to grow a healthy crop profitably applying sustainable and environmentally safe technologies. IDM practitioners significantly decreased the frequency and quantity of chemical pesticide application with increased income. It also contributed to reduce pesticide hazards to human as well as environment health.

Increased Potato Storage Facilities

In higher elevations above 1500masl ambient temperature is favorable for potato storage in zero energy Cellar or Rustic stores. On the contrary in lower elevations in Terai and Dun/Bhabar potato is harvested during beginning of hot and dry summer making it difficult to store potatoes under ordinary environmental conditions and potato is stored in cold stores. At present there is total storage capacity for storing 87,700mt of potatoes in the country (NPDP, 2013/014) and central region occupies about 70% of the space.

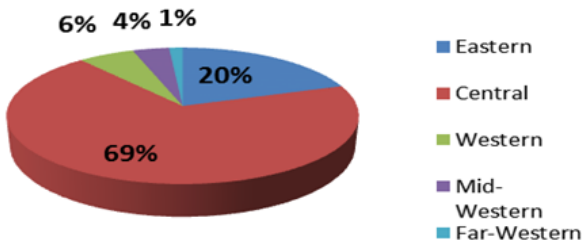

Figure 7. Available storage space (%) in the region share of total 87700mt.

IMPORT-EXPORT

Nepal is importing potato mainly from India and China both fresh and processed forms. The major items are seed, ware, starch, chips and potato prepared or preserved otherwise than by vinegar of acetic acid. It is estimated that Nepal expends more than NRs 2.5 billion annually for importing such products (NPDP report 2013).

MAJOR CONSTRAINTS

Some of the major constraints in potato research and development to enhance overall potato industry in Nepal are as below:

- Inadequate human resource and physical facilities for RandD
- Wider gap in seed production and demand
- Low level of technical know-how
- Degrading soil fertility
- Limited irrigation facilities

- Insufficient cold storage facilities
- Less incentives to encourage farmers and intermediaries
- Increasing agriculture labor scarcity in rural areas
- Weak market information system (MIS)
- Lack of coordination/linkage among production, marketing, and processing

FUTURE PROSPECTS

In the context of rapid urbanization, fast growing population and changing food habit of the people, potato could be an important demanding commodity in daily dietary menu with higher transaction the growing future market. Since potato produces more food per unit area and per unit time, it bears full potential to contribute to food security and poverty alleviation in the country, however, existing production constraints (management of clean seed, diseases and insect pests, variety improvement and processing system) must be realized, given focus and resolved (Khatri, 2000).

CONCLUSION

Larger potential benefits are likely to come from improved control of late blight, virus disease and improved supply of quality seed as recognized as one of the major constraints remained to improve in Nepal. The ecological opportunity in Nepal is far more suitable and gifted for year round fresh potato production to full fill the increasing demand of internal as well as export market. Furthermore, consumers' awareness on hazardous pesticide use in agriculture sector should be considered in potato cultivation as well for safe and healthy product applying integrated disease management (especially of virus and fungal diseases), integrated pest management and marketing systems improvement should be the highest priority needs. Benefitting farmers, intermediaries and consumers is a collective agenda of both research and development agency which needs to be supported by national and international donor and scientific communities strengthen potato RandD to cater future need and hope.

REFERENCES

ABPSD, 2014. Statistical information on Nepalese Agriculture, Agri-business Promotion and Statistics Division, MoAD, Singhadurbar, Kathmandu, Nepal

ABPSD, 2013. Statistical information on Nepalese Agriculture, Agri-business Promotion and Statistics Division, MoAD, Singhadurbar, Kathmandu, Nepal

Khatri, Bhim, 2000. Potato Crop in Nepal: Status and Prospects, In Proc. Of Potatoes 2000, "Linking research to practice" Australian Potato Research, Development and Technology Transfer Conference, 31 July to 3 August 2000, Adelaide, Australia

Lama, T.L. 2001. Status, Prospect and Strategy in Utilizing True Potato Seed (TPS) in Nepal.In Proceedings Regional Workshop on TPS in Asia: Prospect and Strategies in the New Millennium, 26-30 January, 2001. Bangladesh Agricultural Research Institute, Joydepur, Gazipur, Bangladesh

NPDP 2014. Annual Report, 2013/14, National Potato Development Program, Khumaltar, Lalitpur, Kathmandu, Nepal

NPDP, 2002. Field Guides and Technical manual for Farmer Field School for Integrated Crop Management of Potato: 2002, National Potato Development Program, Khumaltar. Editor Tara L Lama.

NPDP, Annual Reports, 2059/60, 2069/70, 2070/71, National Potato Development Program, Khumaltar, Lalitpur, Nepal

NPQD, 2012. Annual Report, . National Plant Quarantine Directorate, Hariharbhawan, Lalitpur, Nepal

NPRP, 2013. Annual Report, National Potato Research Programme, Nepal Agricultural Research Council, Khumaltar, Lalitpur, Nepal.

PDP, 1994. Study on potato export- import in Nepal, 1993/94. Potato Development Program, Khumaltar, Lalitpur, Nepal

PDS, 2001. Annual report on IDM in potato through FFS in Nepal. Khumaltar, Kathmandu, Nepal.

Thapa, B., D.N. Ojhja, B. Sha, and O. H. Hidalgo, 1999. Manual to guide seed producer groups for the implementation of rules and regulations for seed potato in Nepal. NPDP, Khumaltar, Nepal.

DEVELOPMENT AND PROSPECTS OF SPICES IN NEPAL

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ABSTRACT

Turmeric and chillies are the foremost important spices and about 30 spices are in Nepalese culinary use. Major spices commercially grown in Nepal are large cardamom, ginger, garlic, turmeric, chillies and onions. Tree spices Cinnamon and Timur (Xanthoxylem) grown in-situ and now their cultivation has been initiated. Nepal is the world's third highest ginger producer [235,033MT], area wise 5th (19,376 ha) and productivity wise 8th (13.45 t/ha) in position. Large cardamom is the number one export commodity with the highest share value [79%] of the total spice export. All together 76,335ha is under spice cultivation with a total production of 672,384 MT annually. Despite of poor technical knowhow and poor infrastructures international trade on spice is almost balanced, there is just deficit of Rs 559 million (10%) in export as compared to import value RS.5443.8 million. Coriander, fennel, Aniseed, onion, chillies specially 'Akabare khursani' have the ample scope of increasing production. Among the tree spices Cinnamon and Timur is also important to promote in mid hills. Saffron is extremely high value spice for the mountain regions. Spices have tremendous scope of production in the existing multi environmental conditions of Nepal. This paper briefly gives an introduction to the major spices that are grown, their present status and prospects in Nepal.

INTRODUCTION

International Standard Organizations (ISO) has defined spices as "Any of the aromatic vegetable products used in cooking, seasoning and preserving the foods". In a simple definition "Spices are natural products of plant origin, used primarily for flavoring, seasoning or adding pungency and flavor to foods and beverages[Ferrel, 1985]. Dry parts of aromatic plants such as root (sweet flag), bark (cinnamon), rhizome (ginger), leaf (bay leaf), shoot and leaves (coriander), flower bud (clove), stigma (saffron), fruit (Nutmeg), seed (cumin) and resinous exudates (asafetida) have been considered as spices in the international spice trade. Various spices, condiments and herbs mainly contribute taste, flavor and aroma in foods. Majority of spices are grown in tropical to sub-tropical but some spices (saffron, black cumin and Jimmu) are grown in temperate climates. Hence almost all countries produce one or more spices and herbs. Of the 109 spices listed by the ISO, India grows 52 spices [Ravindran, 2006] and Nepal about 30 spices either in-situ or in cultivated conditions [Sharma, 2013]. Nepalese people use many indigenous and imported spices on daily basis or at week intervals or at special social functions.

Spices are used in various forms and ways, pickles (peppers, garlic, ginger, chillies), as preservatives (clove, black pepper, mustard seeds/ powder), coloring (turmeric, chillies, saffron), spice oils [ginger oils] for the preparation of soft drinks and the oleoresins obtained from black pepper, ginger, capsicum, turmeric, fenugreek and cardamom are used for pungency, flavor and aroma in meat and food processing industries. The intrinsic quality of spices and herbs varies with variety, location, time and stages of harvest, processing methods, etc. Resinous part, which is the non-volatile portion, is made up of different polymers. The main flavoring effect in many spices is pungency.

Several valuable pigments are found in spices. These pigments are extracted and used as natural colorants in the food industry. Some of the spices, which yield color pigments, are turmeric, paprika and saffron.

Cardamom contains 2.7 to 3.6 % volatile oil and oleoresin 6 to 7 %. Essential oil possesses medicinal properties like carminative, stomachache, diuretic and cardiac stimulant, etc. Dried ginger contents 2-4% oil and 6-9% oleoresin and many antibiotic and antifungal properties. It is the main constituent in most of the Aaurvedik medicines [Sharma and Shrestha 2002]. About thirty spices have been in use in Nepal (Table 1). Some of them are imported from India and overseas countries and most of them are cultivated or available under in-situ conditions of Nepal.

Table 1: List of spices commonly used in Nepal

SN	English name	Nepali name	Botanical name	Parts used
1	Turmeric	Besar/Haledo	Curcuma longa L.	Rhizome
2	Chilli	Khursani	Capsicum frutescence L.	Fruit
3	Fenugreek	Methi	Trogonella foenum graecum L.	Seed
4	Garlic	Lasun	Alliam sativum L.	Leaf and bulb
5	Onion	Pyaj	Allium cepa L.	Leaf and bulb
6	Coriander	Dhaniya	Coriandrum sativum L.	Leaf and seed
7	Ginger	Aduwa	Zingiber officinale Rosc.	Rhizome
8	Cumin	Jeera	Cuminum cyminum L.	Seed
9	Black cumin	Himali jeera	Bunium persicum Bioss	Seed
10	Black pepper	Marich	Piper nigrum L.	Berry
11	Indian cassia	Tejpat	Cinamomum tamala Neesand Eberm	Leaf and bark
12	Cinnamon	Dalchini	Cinnamomum zeylanicum Blume.	Bark
13	Clove	Lwang	Eugenia caryophyllus Bullock and Harrison	Flower bud
14	Cardamom (Large)	Alainchi	Amomum sabulatum Roxb.	Fruit and seed
15	Cardamom (Small)	Sukmel	Elettaria cardamomum Maton.	Fruit and seed
16	Nutmeg	Jaiphal	Myristica fragrans Houttuyn	Kernel
17	Mace	Jaipatri	Myristica fragrans Houttuyn	Aril
18	Bishop's weed	Jwano	Trachyspermum ammi L.	Seed
19	Aniseed	Saunf (masino)	Pimpinella anisum L.	Seed
20	Black mustard	Katherayo	Brassica nigra (L.) Koch	Seed
21	Asafoetida	Hing	Ferula asafoetida L.	Resin from rhizome
22	Saffron	Kesar	Crocus sativa L.	Stigma
23	Mint	Pudina	Mentha arvensis L.	Leaf
24	Leek	Chhyapi	Alliam ampeloprasum var. porrum	Leaf and bulb
25	Nepal pepper	Timur	Znthoxylum armatum DC	Fruit
26	Fennel	Sounf (moto)	Foeniculum vulgare Mill.	Seed
27	Dill	Nepali soof	Peucedanum graveolens (L.) CB Clarke.	Seed
28	Caraway	Himali soop	Carum carvi L.	Seed
29	Nigela	Mungrelo	Nigella sativa L.	Seed
30	Jimmu	Jimmu	Allium hypsistum L.	Leaves

Source: Sharma, 2013

INVOLVEMENT OF DEVELOPMENT ORGANIZATION

In Nepal, there are two apex organizations for research and development of spices. (i) National Ginger Research Programme, Kapurkot, Salyan under Nepal Agricultural Research Council (NARC) and (ii) National Spice Crop Development Programme, Khumaltar and its collaborating stations e.g. Spices Development Center, Panchkhal, Kabhrepalchok and Cardamom Development Center, Fikkal, Ilam under Department of Agriculture. National Spice Crop Development Programme, Khumaltar/DoA run Cardamom disease management and nursery establishment programme since five years to minimize the disease and increase production of cardamom, likewise Ginger promotion programme to increase the production and add the value of the product. Projects run in collaboration with Ministry of Agriculture Development; High Value Agriculture Project [HVAP], out of 7 selected value chain commodities three are spices [Ginger, Turmeric and Timur], have been included for 7 Districts, Raising Income of Small and Medium Farmers Project [RISMFP] at 10 districts of mid and far western regions for the promotion of ginger and turmeric. Commercial Agriculture Development Project (CADP) has supported for the promotion of ginger and cardamom in the eastern region. UNNATI Project also has some programme for the promotion of ginger and cardamom at eastern hill districts. Ginger is one of the most important export commodities under National Trade Integration Strategy [MoCS/GoN, 2010] under the Ministry of Trade and Industries since 2010. A part from Government organization, Cooperatives, NGOs and INGOs are also involved for developing entrepreneurship on production and processing of spices. Mercy Corps, GTZ, Samarth-NMDP [Nepal Market Development Programme], High Mountain Agri-business and Livelihood Improvement (HIMALI) has also given due priorities on cardamom in most of the project districts and saffronin Jumla. Cooperatives in Palpa, Pyuthan and Ilam at community levels and Nepal Ginger Producers and Traders Association [NGPTA] at Dhulabari, Jhapa are also taking part in production and trading of ginger in eastern region. Federation of Large Cardamom Entrepreneurs of Nepal (FLCEN), Birtamod, Jhapa has also been taking part on promotion and trading of large cardamom in country. It has already made the network on major cardamom producing districts. The Enhanced Integrated Framework (EIF) and World Trade Organization Standards and Trade Development Facility (WTO-STDF) have funded 11 million U.S. dollars to enhance the capacity of ginger producers in Jhapa, Panchthar, Ilam and Morang districts. Under this project, there was planned programme of installing a rhizome washing facility with 100 MT daily cleaning capacity at Dhulabari of Jhapa. Micro Enterprise Development Programme [MEDEP] with the financial support of UNDP had a significant contribution on processing and value addition of ginger in several mid hill districts. Project for Agriculture Commercialization and Trade [PACT] and USAID funded project Nepal Economic Agriculture and Trade [NEAT] have also supported promotion of ginger and cardamom to some extent.

All the spices defined and listed above have not been dealt by the Ministry of Agricultural Development and the mandated organization for spices. Dalchini [Cinnamon] and Timur [Xanthoxylum] come under Ministry of Forest and Soil Conservation [MFSC].Cardamom, Ginger, Turmeric,Onion, Garlic and Chili are under the Vegetable Development Directorate, Khumaltar. Two organizations deal on single commodity i.e. fresh ginger is dealt by MoAD whereas, dried ginger [Sutho] is being traded as Judibuti by MFSC.

CULTIVATION AREA AND PRODUCTION STATUS

Most of the spices are shade loving that can be grown in between the rows of orchard or inter cropped with other vegetable crops, which increases the cropping intensity as well reduces the risk of crop failure. Total area under spices is 76,335 ha with a production of 6,72,384 MT and ginger occupies highest area and production followed by onion and cardamom. Presently, five spices have attained a commercial production scale (Table 2) and some spices such as onion, coriander, fenugreek, saffron, cinnamon and timur are coming up. Seed spices particularly cumin, black cumin, bishop's weed, aniseed, black mustard, fennel, dill, caraway, nigela, Xanthoxylem and other spices cinnamon, saffron, are limited in backyard or in-situ conditions. All these spices should be promoted for commercial production that could help in minimizing the trade imbalance and increase income and employment opportunities in the country.

Table 2: Area, production and productivity of commercial spices in Nepal

Spices	Productive Area (ha)	Production (MT)	Productivity (t/ha)
Cardamom	11501	5225	0.45
Ginger	24224	276150	11.40
Garlic	6569	45035	6.86
Turmeric	7310	67631	9.25
Chili	8033	35668	4.44
Onion*	18698	242675	13.0
Total	76335	672384	

*Source: Vegetable Development Directorate, Khumaltar

Ginger is the single spice commodity showing third position in the global ranking, fifth position in area and eighth position in productivity [FAO 2015]. India is first in area as well as in production but productivity far below than Nepal. Highest productivity of ginger [32.55 t/ha] has been recorded in Fiji [Table 3].

PROCESSING AND VALUE ADDITION

There is almost lacking of appropriate technologies on post-harvest handling, drying and packaging of spices. In traditional manner, large cardamom is smoke dried and packed in gunny bags without doing other value addition. Likewise ginger is peeled without washing and dried over the muddy place in open air for 15-20 days or dried under hot smoke to make gola sutho [round black dry ginger]. Little technological intervention has been made on cardamom and ginger for better processing and disseminating to farmers and entrepreneurs, although through proper technological interventions quality of dried cardamom capsule can be improved and marketed with increased value. Likewise in ginger, a series of value added processed productsare prepared- i.e. solar dried ginger [sutho], ginger powder, ginger candy, ginger squash, ginger tea, ginger shampoo and several other items by farmers groups and entrepreneurs.

Table 3: Top ten countries in the world with respect to cultivation area, production and productivity in 2013

Cultivation Area		Production		Productivity	
Country	ha	Country	MT	Country	t/ha
1. India	136000	1. India	683000	1. Fiji	32.55
2. Indonesia	51700	2. China, mainland	390000	2. USA	29.77
3. Nigeria	50000	3. Nepal	235033	3. China [Taiwan]	29.17
4.China [mainland]	37000	4. Indonesia	232669	4. Japan	27.67
5. Nepal	19376	5. Nigeria	160000	5. Mauritius	16.80
6. Thailand	9000	6. Thailand	140000	6. Thailand	15.56
7. Bangladesh	8400	7. Bangladesh	69000	7. Kenya	13.20
8. Cameroon	5381	8. Japan	57835	8. Nepal	12.13
9. Philippines	3914	9. Cameroon	46350	9. Costa Rica	11.13
10. Ethiopia	3500	10. China [Taiwan]	35000	10. China mainland]	10.54

Source: FAO-STAT updated up to 2013, recovered Sep 2015

Spices are marketed as whole seeds, barks, leaves, buds, stigmas, and rhizomes or grounded of all these spices. Apart from these plant parts, majority of these spices are used for extraction of essential oils and oleoresins. Ginger oil and ginger oleoresins are the two main ginger products in the international markets [Bhatiya et al 1999]. In case of ginger, 80% of produce is exported as fresh rhizomes and 10-20% processed for dry ginger [NGRP, 2008] and negligible amount is used for making value added ginger products like dry slices, candy, squash, powder and ginger pickles which are consumed locally. Essential oils are the fragrant products obtained from natural raw materials by hydro-distillation or steam distillation or by Supercritical Fluid Extraction [Anonymous. 2003]. Small scale cottage industries (Masala Udyog) prepare value added spice products utilizing raw spices, produce as singleor mixed masala powderpackets of cumin, coriander, turmeric, chilly, black pepper etc. Processing techniques to ensure uniform color, attractive appearance, increased quality along with healthy and attractive packaging is another emerging area of value addition.

NATIONAL AND INTERNATIONAL TRADE

More than 50% of total spice import is basically from India and obviously major market destination is also India. However, total spice trade would be more than that because of illegal entries from the open borders. Overall export of spices is equivalent the value of NRs 4883.9 million against the import value of 5443.8 million Rupees in 2013/14 (Table 4). Large Cardamom is the first spice commodity which shares 87% of export value followed by ginger [9%] and rest of the spices 4 percent. Regarding import four commodities pepper, cumin, capsicum/chilly and small cardamom shares 79 % of import value.

Cardamom and ginger are among the top 10 trade commodities prioritized by the Industrial Policy 2010 and plans to provide additional incentives and facilities for the promotion of these spice crops [MoCS/GoN. 2010]. ADS 2015 has also given due priorities on these spices. Cumulative efforts and impact of all stakeholder producers, entrepreneurs, traders, NGOs and Government Organizations reflects on the export and import scenario of spices [Table 4]. In comparison to cereals and other food commodities spice trade is almost balanced due to the major role of cardamom and ginger. Cinnamon is also contributing to some extent in trade balance. Timur [Xanthoxylum] which is exported in large volume and value usually does not come under MoAD statistics but it is the most exportable spice commodity. Timur is found naturally in 30 districts of Nepal out of which Achham, Dailekh, Jajarkot, Kalikot, Salyan, and Surkhet are the major potential districts exporting about 220 MT annually [Anonymous, 2011]. It indicates that Nepal's agricultural trade policy should led emphasis on the promotion of this important spice. Turmeric, coriander, fenugreek, cumin, garlic, onion and saffron are the future priority spices crops which could be grown extensively and the government should have appropriate promotional policy. Thus, there is high scope to increase productivity, availability and distillation in the country with ample possibility of value addition[http://thespicejournal.com/about -spice-Nepal/]. Overall there is significant trade deficit of

Rs. 559 million (10%) per year [Table 4].

Table 4: Import and export of spices in 2013/14

SN	Commodities	Import quantity and value		Export quantity and value		Trade balance
		[Kg]	NRs [000]	[kg]	NRs [000]	NRs[1000]
1	Annise, Fennel	447599	54849	735	21	-54828
2	Capsicum	6075477	925809	0	0	-925809
3	Cinnamon	474160	59594	925394	67437	7843
4	Cloves	215834	92442	250	72	-92370
5	Coriander	3917448	383612	60	1	-383611
6	Cumin	6497147	1182585	60	36	-1182550
7	Fenugreek	1531231	118090	7725	1581	-116509
8	Garlic	740118	66857	8017	2472	-64385
9	Ginger	2299983	188861	20415666	449901	261040
10	Large cardamom	1414	584	4913890	4270372	4269788
11	Nutmeg	27496	10347	0	0	-10347
12	Onion	154583	11152	19000	11212	61
13	Pepper	2428676	1459023	13410	1812	-1457210
14	Saffron	1651	6769	0	0	-6769
15	Small Cardamom	1814522	726733	0	0	-726733
16	Spices	1075609	136262	1206148	74452	-61810
17	Turmeric	166945	20206	20572	4617	-15589
18	Vanilla	1211	114	0	0	-114
	Total	27871104	5443888	27530927	4883986	-559903

Source: MoAD, Year Book, 2014

SPICES UNDER CULTIVATION

Cardamom

Large cardamom is the world's third-most expensive commodity after saffron and vanilla. This is mainly grown in the sub-Himalayan region of India and Nepal between an elevation of 600 to 2000 msl where annual rainfall is between 1,500 to 2,500 mm and the temperature varies from 8° C to 20° C (Dhital and KC, 2069 BS). It was introduced from Sikkim in 1865. After the establishment of Cardamom Development Centre at Fikkal in 1975 its cultivation extended to 42 hill districts. However, 73% of total national production still comes from four eastern districts (Taplejung, Panchthar, Ilam and Sankhuwasabha [Anonimous, 2015]. Out of 16 cultivars grown in the world, the most popular varieties of Large Cardamom in Nepal are Ramsai (1500-2000 meter msl) and Golsai (1200-1600 meter msl). However Saunae (700-2000 meter), Ramla, Chibae, Dammarsai, Varlangae (1500-2000 meter msl), Jirmalae (600-1200 meter msl) are found sparsely cultivated. Farmers from remote districts follow traditional methods of large cardamom cultivation which are eco-friendly and less costly due to utilization of local resources, family labor and traditional wisdom (Gaudae et al., 2013). Recently at Ilam, 'Salakpure' a new cultivar is being tested in farmer's field since three years [Anonymous 2015].

Propagation is done through seeds and suckers. The major problem to this crop is the widespread occurrence of the viral diseases such as streak mosaic (Chhirke) and stunt mosaic (Furke) caused by 'Mosaic streak virus' and 'Bushy dwarf virus' respectively [Subba and Ghimire, 2009]. Vectors of these two viruses are two species of aphid Myzus persicae Sulzer and Micromyzus kalingpongensis Basu [Pun, 2007] respectively. Recently, another devastating fungal disease known as Colletotrichum blight is becoming serious threat and lack of phytosanitary measures causing much serious threat to the whole cardamom industry of Nepal. Farmers are unwilling to replace the diseased Large Cardamom-orchard. Vegetative propagation is still under practice. Even though farmers want to replant seedling, they are unable to buy at reasonable rate as well as in sufficient quantity. Indiscriminate planting of available land races from unknown source without considering climate and altitudes is another major issue. So far disease resistant variety is not available to Nepalese farmers. Apart from the diseases, post-harvest handling and processing are the major problems in cardamom. Conventional drying using firewood makes the cardamom of inferior quality because of smoky appearance and reduced oil content. Dried capsules are packed into gunny bags and marketed to India. There is high possibility of doubling the price of cardamom through value addition in drying, cleaning and marketing by attractive packaging. Double drum dryer of cardamom is being practiced for many years for no smoky appearances but in small scale.

Ginger

Ginger is herbaceous perennial spice crop which has been in use for more than 5000 years ago by the ancient Chinese and Indians. India is a leading producer of ginger in the world. It grows well in warm and humid climate and is cultivated from sea level to an altitude of 1500 m above sea level. It also can be grown both under rain fed and irrigated conditions. In Nepal, ginger is cultivated in 24224 ha and total production 276150 MT with the average productivity of 11.44 t/ha [MoAD, 2014]. Productivity is very low as compared to other countries. The major cause of low productivity is rhizome rot disease, unavailability of quality disease-free planting material. Ilam, Nawalparasi, Palpa, Salyan are the lead ginger producing districts. Rhizome rot caused by Pythium aphanidermatum and Fusarium spp. is the main bottleneck of production causing substantial yield loss of 30 percent [Sharma and Shrestha, 2002], however it has the capacity of crop damage up to 100%. It is the third most important exportable commodities after lentil, and large cardamom. Of the total produce 60% is exported particularly to India, 30 % is domestic consumption and 10% is used for seed purpose [Anonymous, 2013].In 2002, a variety 'Kapurkot Aduwa-1' has been released for commercial production and it has high yielding and processing properties. Despite of many constraints, Nepal ranks 5th in area and 3rd in production and 8th in productivity in the world [FAO, 2015].

Turmeric

It has underground modified stem (rhizome) like in ginger. The name turmeric is believed to be originated from the Latin word terra merita meaning merit of the earth. Turmeric rhizomes contain curcuminoids 2 to 6% [Pruthi, 2006], which is responsible for yellow pigments and comprises three types of curcumins. It is also a shade-loving crop and can be grown as intercropped with orchard and suitable for agro-forestry systems. Rhizome rot and leaf spot diseases are the major problems of its cultivation. Dried rhizomes and their powder are the commercial forms. Its cultivation could be scaled up in all the terai and mid hills regions. Turmeric is a mild digestive, stimulant, carminative and beneficial in reducing blood cholesterol, ulcers, dysentery, diarrhea, sore throat, indigestion, cancer and also has antiseptic properties. In 2014, for the first time in Nepal, Kapurkot Haledo-1 a turmeric variety was released for commercial production with high yielding and high curcumin content. Package of practices for this crop was also recommended by National Ginger Research Programme, Nepal Agricultural research Council [NARC].

Chilli

It is an annual herb, which is also called hot pepper, red pepper, cayenne pepper, capsicum, etc. Chilli imparts pungency and color to the dishes. Biting pungency is attributed by 'capsaicin' whereas; 'capsanthin' attributes red pigment [Zibokere, 1994]. It is also a rich source of vitamin A, C and E, and assists in digestion and also prevents heart diseases by dilating blood vessels.

The chilli is propagated by seeds. Chilli requires warm and humid climates for best growth and dry weather during the maturation of fruits and can be grown throughout the year from sea level to 2100m msl. Thrips, mites, aphids and pod borers are the major insect pests and fruit rot, die- back, bacterial wilt, powdery mildew and mosaic are the major diseases of this crop. A single variety 'Jwala' has been released, whereas 15 hybrid chilli varieties are registered for commercial production. Almost all districts grow chilies but commercial producers are Morang, Jhapa, Sunsari, Rautahat, Kathmandu, Banke, Bardiya, Kailali and Kanchanpur districts cultivating chilies in more than 200 ha in each district, with the productivity of 4.44 t/ha. Chillies are grown in 8033 ha in the country.

Coriander

Coriander requires cool climate during the growth stage and warm dry climate at maturity. Two open pollinated varieties [Lotus and Suravi] and three hybrid varieties have been registered after the adaptation testing. Pant Haritama, an Indian variety is under testing at Kapurkot and Dailekh. Aphids, cutworms, fusarium wilt, stem galls and powdery mildews are the major biotic constraints. This crop matures on 110 to 140 days. Terai and Inner Terai are the best-suited areas for its cultivation. It can be intercropped with sugarcane as catch crop before the full growth of sugarcane.

Onion

It is one of the most important and popular vegetables grown successfully in Nepal. It is most popularly used vegetable and spice, which is utilized in every kitchen irrespective of economic status of the family. It contains vitamins 'B' and 'C' and traces of iron and calcium and has manifold medicinal value. A significant amount of onion is being imported from China, India and Thailand. Government of Nepal has launched 'Onion mission' for its promotion and increased production and to substitute import. Variety Red Creol, Agri-found red, Nasik-53 and five hybrid onions are registered for cultivation.

Garlic

In Nepal it is cultivated from Terai to the high altitudes. The variety of garlic cultivated at high altitudes is generally called 'Bhote Lasun'. It has tall plants and large leaves, corms resembles with Chinese garlic. Research has been initiated with local germplasm collection and being evaluated at the agriculture research stations. 'Terai lasun' and 'Bhote lasun' are common in Nepal. These two types may be different species of Allium. The white-skinned bulb or corm is subdivided into several 'cloves'. Garlic contains a wealth of sulphur compounds; most important for taste is allicin (diallyldisulphide oxide). Its biological function is to repel herbivorous animals. Garlic is used as a flavoring agent, vegetable and medicinal herb that has accumulated superstitions over the centuries.

Saffron

Saffron is the highly expensive spice and is basically grown in dry temperate region at altitude ranging from 2500 to 2800m msl. It is perennial c\rop propagated through corms. Dried flower stigmas of saffron are of commercial value. Approximately 150000 flowers are needed for one kilogram of dried saffron. The intensive color of saffron is caused by pigments of carotenoids. The most abundant constituent is 'safranal'. There is high potential of saffron production in the high altitudes of Nepal. Some farmers of Jumla and Humla have initiated growing this crop but have not yet attained commercial production. However HIMALI project has implemented a sub-project on Saffron in Jumla for its production in farmer's field.

CONSTRAINTS OF PRODUCTION, PROCESSING AND TRADE

- Despite of having enormous suitable climates for spices production, suitable policy is lacking to exploit the opportunities.
- Nepal does not have improved high yielding varieties, scientific cultivation practices and appropriate processing technologies. Whatever technologies we have that has long way to reach to the growers and processors.
- Considering its importance in employment generation, earning foreign currency and potential in balancing international trade the commodity is not getting due priorities.
- Few spices research and development farms working on many spices but with minimum human resources
- Since Nepal became a member of WTO, without SPS quality certificate Nepal's processed spice products cannot enter into international spice markets.
- Unwashed [dirty] fresh ginger without SPS certificate gets quarantine problem and Nepali traders are compelled to pay unofficial money to Indian custom office personnel.
- Large cardamom fetches good price but it has to compete with Sikkim and Darjiling products. Because of smoky appearance and low oil content its price is affected.
- Nepalese spice products are unable to meet the minimum standard of American Spice Trade Association [ASTA] and European Spice Association [ESA], to enter into Western countries due to quality issues.

- Lack of proper knowledge on harvesting, grading and local value addition and inadequate capacity of farmers to prepare required technical and business plan.
- Low access to market and its information.
- Inability of farmers, traders, and processors to provide adequate storage facilities for the spices.

PROSPECTS OF SPICES IN NEPAL

The growing demands for organic crop products have led to the development of international trade for organic spices. Europe is the world leading market for organically produced spices. Spice export is always a significant part of total agricultural export of the country. Nepal has diversified climate from tropical to temperate where almost all spices can be grown successfully. Growers will get more returns from spice crops per unit area than cereals and other crops with comparatively less investments and in less time. In addition to cardamom, ginger, turmeric, garlic, onion, chili, other seed spices like coriander, fenugreek, cumin, fennel, Bishop's weed, black mustard can be grown commercially in Terai and mid hills. Cinnamon and Timur can be promoted through adopting improved package of practices in the community forests that will help to reduce soil erosion and increases income of the community through Silvi-horti system [Anonymous. 2003]. Temperate climate in the high mountain regions has provided special opportunities to grow saffron, Jimmu and Himali Jeera. For the promotion of all theses spices, a 'Spice Board' needs to be formed and spices should get due priority for research and development in the country. Special courses should be taught in the agricultural universities. All the Nepalese spices mentioned above need to be dealt by one organization.

In the recent years all over the world, there is a growing trend in the use of various spices in culinary preparations due to changing lifestyle and food habits of the present generation. Spice varieties which have high production potential and better export demand have to be identified for promotion with quality planting materials in large scale and adoption of latest technologies. The present problem of young farmers' migration to foreign job has kept potential cultivable land as fallow. Rejuvenation of unproductive fallow land for the scientific cultivation of suitable spice crops should be given high priority. There is urgent need of establishing oils and oleoresin extraction plants in the country. Ample raw materials [ginger, turmeric, chilli, cardamom, timur and cinnamon] are now available for the oil and oleoresin extraction. Spice as low volume commodity and with qualitative production and processing, Nepal can directly penetrate into European and American spice trade by air. A prioritized group value chains leading to national program to develop competitive agricultural value chains that increase value added and benefits to smallholder farmers [ADS, 2015] needs to be included in the programme.

Among seed spices cumin, coriander, fennel in terai and valleys, tree spices Xanthoxylem [timur] and Cinnamon [Dalchini] in mid hills and Saffron in high hills should be promoted for commercial production. There is need of exploring value added spice products in the international market under our own Nepalese trade mark. Chilli, particularly Akabare Khursani; one of the most pungent spices grown in eastern hilly region is of best quality in containing 'Capsasin' and has great market value. Its oleoresin content has special medicinal value that is the best of its kind in the world. We need further sincere efforts to explore, promote and increase productivity and value addition. Spice has the ample scope to balance the agricultural international trade deficit of Nepal.

REFERENCES

ADS. 2015. Agriculture Development Strategy (ADS) 2015-2035. Government of Nepal, Ministry of Agricultural Development. Part-1

Anonymous. 2003. Spices crops of India. Edited Prem Singh Arya. Kalyani Publishers, New Delhi, India. pp 1-7

Anonymous. 2011. A Report on Value Chain Analysis on Timur. Govt. of Nepal, Ministry of Agricultural Development, High Value Agriculture Project in Hill and Mountain Areas [HVAP). pp 45.

Anonymous. 2013. Annual Report of 2012/13. National Spice Crop Development Programme, Khumaltar, Lalitpur, Nepal. pp 61.

Anonymous. 2015. Trade Flow Analysis of Large cardamom in Eastern Region. Ministry of Agricultural Development, Agribusiness

Promotion and Statistics Division, International Trade Promotion Section, Singh durbar, Kathmandu, Nepal. 72 pp.

Bhatiya, A.M., Hazarika, N. and Singh, R. 1999. Spices and fruits for micro-enterprises, A study of the potentials of ginger and pineapples in West Garo Hills, Meghalaya, India. International Centre for Integrated Mountain Development (ICIMOD) Kathmandu, Nepal

Dhital, S. and KC, Rabi. 2069 BS. Alainchi Kheti (Nepali). Rastriya Masala Bali Vikash Karyakram, Khumaltar, Lalitpur, Nepal. Pp 54.

FAO, 2015. http://faostat3.fao.org/download/Q/QC/E

Ferrel, K.T. 1985. Spices, Condiments and Seasonings. AVI Publ., Co., USA.

http://thespicejournal.com/about-spice-nepal/

MoAD. 2014. Statistical Information on Nepalese Agriculture. Ministry of Agricultural Development, Agribusiness Promotion and Statistical Division, Agriculture Statistics Section, Singh Durbar, Kathmandu, Nepal.

MoCS/GoN. 2010. Nepal Trade Integration Strategy 2010: Executive Summary and Action Matrix. Kathmandu: Ministry of Commerce and Supplies, Government of Nepal.

NGRP. 2008. Annual Report, National Ginger Research Programme, Kapurkot, Salyan, Nepal.

Pruthi, J.S. 2006. Spices: Processing technology and product development in India. In: Advances in Spices Research. Edited Ravindran,P.N., Nirmal Babu, K., Shiv, K.N. and Kallupurackal, J.A. Agrobios (India). pp 1-42.

Pun K.B. 2007. Diseases affecting large cardamom in India and their management. Paper presented in National Seminar on Indian Spices: Research Advances and Utilization. Directorate of Research, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal, India.

Ravindran, P.N. 2006. Spices: Definition, classification, history, properties, uses and role in Indian life. In: Advances in Spices Research. Edited Ravindran,P.N., Nirmal Babu, K., Shiv, K.N. and Kallupurackal, J.A. Agrobios (India). pp 1-42.

Sharma, B.P and Shrestha, S.K. 2002. Survey of rhizome rot of ginger in Nepal and options for the disease management. Nepal Agri.

Research Journal 3:1-7

Sharma, B.P. 2013. Spices. In book. Environment and Natural Resources. Eds, P. K. Jha, F.P. Neupane, M. L. Shrestha and I. P. Khanal. Nepal Academy of Science and Technology, Khumaltar. Vol. 1, pp. 453-464.

Subba, N. and Ghimire, K. 2009. Large cardamom management technology. Nepal Agricultural Research Council, Agriculture Research Station, Pakhribas, Dhankutta, Nepal. pp 67-70.

Subba, N. and Ghimire, K. 2009. Large cardamom management technology. Nepal Agricultural Research Council, Agriculture Research Station, Pakhribas, Dhankutta, Nepal. pp 67-70.

Zibokere, D.S. 1994. Indian J. Agril. Science. 12: 74-80.

TEA DEVELOPMENT IN NEPAL: OPPORTUNITIES AND CHALLENGES

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ABSTRACTS

The global tea connoisseurs had already remarked Nepali tea as one of the best ever in the world. This connotation itself is a self explanatory that clearly indicates the future of tea in Nepal. Nepal has one and half century experience in tea development sector. But, tea industry in Nepal took momentum only after the private sector involved in this sector. Tea is recognized as third export item of Nepal. Tea, scientifically known as camellia sinesis is not a new object for Nepal. The history of tea in Nepal dates back to 1863 AD when the first tea plantation was noticed in Ilam district. After 1950 democratic movement, the door opened for private sector to invest in tea industry. Following after formation of NTCDB, the National Tea Policy has been introduced in the year 2000. In Nepal, tea sector contributes 0.17 percent to the total Agriculture Gross Domestic Products (AGDP) and also contributes 6.48 percent to the total agro products export. Tea sector is also a very good platform for employment generation particularly for rural women employment. Beside that it is a good source of revenue for the government. There are many challenges that yet to be addressed by the related stakeholders. Technical Barriers to Trade (TBT) agreement was one of the mandatory obligations of the World Trade Organization (WTO). Nepal as a member of the WTO must follow the TBT provision. Quality Certification is another big challenge in tea sector. Furthermore, price competitiveness is also a great challenge. In Nepal, auction system is not yet introduced. Auction market is necessary to bring together buyers and sellers, and ensure transparency. It is already cleared that tea is a potential export oriented cash crop to earn foreign currency with many opportunities to develop this sector. Therefore, both the public and private sectors involving in this sector must be prudent to cash in the opportunities. If the quality and standard issues are taken seriously by the Nepalese tea traders, Nepal, no doubt, can increase its share in the global market.

The unique geo-physical character and climatic variation permits a wide range of Orthodox and CTC tea production in Nepal. Outstanding aroma, fusion, taste and color are the attribution of Nepali tea. The global tea connoisseurs had already remarked Nepali tea as one of the best ever in the world. This connotation itself is a self explanatory that clearly indicates the future of tea in Nepal.

Nepal has one and half century experience in tea development sector. But, tea industry in Nepal took momentum only after the private sector involved in tea market. The area and production of tea is increasing in each year as compared to its previous years. Out of total Orthodox tea production, only 7 to 10 percent are being consumed in home and the rest are being exported. There are many orthodox tea factories in Nepal including 24 large ones. It is estimated that an approximate of 3500 tons of orthodox tea are exported annually. In 2011, 166 farmers were certified as "organic" by the Institute of Marketecology (IMO) which is officially recognized by the EU Commission. Another 64 were in transition stage.

Tea now is recognized as third export item of Nepal. Similarly, Nepal Trade Integration Strategy (NTIS) 2010 has identified tea as an "export potential sectors" in Nepal. It has widespread socio-economic implication for the country. In Nepal, tea sector contributes 0.17 percent of the total Agriculture Gross Domestic Products (AGDP) and also contributes 6.48 percent to the total agro products export. At present, half of the total CTC tea produced in Nepal is enough to meet the domestic market. Albeit it is steady, it is good sign for the stakeholders involving in tea sector.

THE HISTORY

Tea, scientifically known as camellia sinesis is not a new object for Nepal. The history of tea in Nepal dates back to 1863 AD when the first tea plantation was noticed in Ilam district. Mr. Gajraj Singh is said to be the first tea planter in Ilam. The first tea entrepreneurship was born in 1878 establishing a tea processing factory in Ilam district. After long time interval, the Soktim Tea Estate was established in Jhapa district. It would be noteworthy that tea plantation started in Darjeeling in the same decade. However, the budding tea industry of Nepal could not take pace and failed to fulfill even domestic demand of tea due to the political disorder during Rana reign.

After 1950 democratic movement, the door opened for private sector to invest in tea industry. As a result, the first private sector driven "Budhakaran" Tea Estate was established in 1959. Nepal Tea Development Corporation (NTDC) was set up in 1966. It could be considered as the first positive intervention of the government in tea development sector. Another tea processing factory was set up in Ilam in 1978. Few years later, another factory was set up in Soktim, Jhapa.

In 1982, during the reign of King Birendra, the government of Nepal declared Jhapa, Ilam, Paanchthar, Dhankuta, and Tehrathum district as tea zone of Nepal that added new dimension in tea development sector. The NTDC had made good efforts to boost up tea sector during period of 1978 to 1990. At the same time, the government has introduced privatization and liberalization policy to encourage the private sector to invest in tea development sector. The nation felt necessary to boost up coffee sector also side by side with tea sector and formed Nepal Tea and Coffee Development Board (NTCDB) in 1993 under Tea and Coffee Development Board Act 1992 of Nepal. Following after formation of NTCDB, the National Tea Policy has been introduced in the year 2000. The policy as such has focused on institutional development of tea sector in Nepal.

At present, there are 140 registered Tea Estates that contributes 85 percent of the total national tea production. Similarly, there are 40 tea processing centre (Orthodox – 25 and CTC 15). About 60 tea related cooperatives are running in the country. Many vicissitudes have been crossed to reach to the present situation of tea development in Nepal.

PRESENT STATUS

Area and Production

According to NTCDB, Nepal is self sustained in CTC tea. The half of the total CTC production is enough to meet the domestic market.

The area and production of tea in general is increasing in each year due to expansion of area. Previously, the area under tea cultivation was limited in few districts. But, now it has been extended in different parts of the country like Taplejung, Nuwakot, Sindupalchowk, Dolkha, Sankhuwasabha, Bhojpur, Gorkha, Kaski, Solukhumbu, Lalitpur, Okhaldhunga, Kavre, Sindhuli, Dhading, Rasuwa, and Khotang districts. There is still opportunity for expansion of the tea cultivation area in the country.

Following graph depicts the area and production of tea in Nepal.

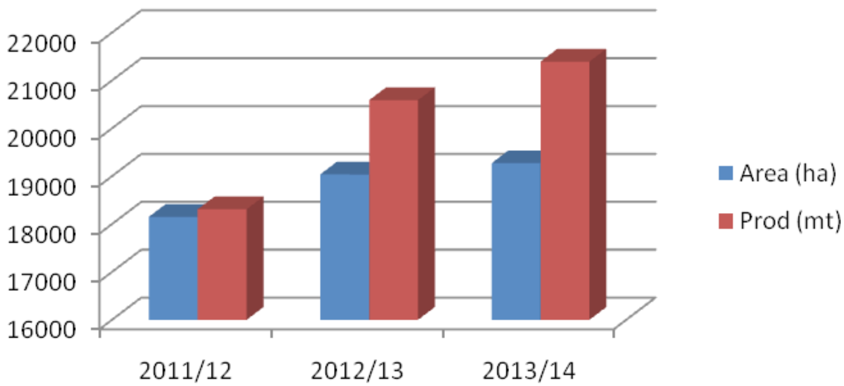

Figure 1: Area and Production Trend of Tea in Nepal

Above graph clearly shows the increasing trend of tea area and production in Nepal. In 2011/12, the area under tea cultivation was 18309 ha, that was increased by 887 hectares in 2012/13 and finally in 2013/14, the area coverage reached to 19271 hectares. The production is also increasing each year. The tea production in 2011/12 was 18309 tons, in 2012/13 it was 20588 tons and in 2013/14, it was recorded to 21394 tons.

The breakdown of tea area and production by types of tea is shown in the table below.

Table 1: Area and Production of Orthodox and CTC Tea in Nepal 2012/13

	Orthodox		CTC	
	Area (ha)	Production (mt)	Area (ha)	Production (mt)
Garden	3383	986.7	6569	11133.5
Farmers	5403	2050.9	3681	6416.8
Total:	8786	3037.6	10250	17550.45

Similarly, the table below shows the area and production of tea under tea zones and other areas.

Table 2: Area and Production of Tea Zones (2013/14)

District		Area (ha)	Production (Mt)
1.	Jhapa	10325	18045
2.	Ilam	5742	2744
3.	Dhankuta	467	154
4.	Paanchthar	938	264
5.	Tehrthum	287	69
6.	Others	1517	118
Total:		19271	21394

Source: Statistical Information on Nepalese Agriculture, 2013/14, MoAD

EXPORT AND IMPORT

The share of Nepali tea in the global export markets is nominal. It is about 2-3 percent only. Though small share, the export scenario is positive. Each and every year the volume of export is increasing. Nepal exports 95 percent of the total Orthodox tea produced in Nepal. Similarly, out of the total CTC tea production, about 55 percent is being exported specially in India, Pakistan and Bangladesh. In 2013/14, Nepal earned 2 billion Nepalese rupees exporting 11,923 tons of various categorized tea components such Green tea without fermentation in immediate packaging, green tea not fermented, black tea fermented and partly fermented, and black tea fermented in different global markets. In the same year, Nepal imported 299.2 tons of all those categorized tea from different countries.

On the other hand, the volume of import has been found fluctuated, primarily the CTC tea. Details are given in table no. 4 and 5 below.

Table 3: Export FY 2013/14

Types	Exporting Partners	Unit	Quantity	Value (NRs)
1. Green tea not fermented in immediate packaging	China, Japan, Singapore, Thailand, India, Canada, USA, Denmark, France, Germany, UK, Czech Republic	kg	115873	11661691
2. Green tea not fermented	Japan, Korea R, Malaysia, India, Germany, Ukraine, Australia	kg	129648	20326182
3. Black Tea fermented and partly fermented	China, Japan, India, Canada, USA, France, Germany, Netherlands, UK, Norway, Russia, Ukraine, Russia	kg	696936	24148449
4. Black Tea fermented	Myanmar, China, Hongkong, Japan, Malaysia, Philippines, Qatar, Singapore, Taiwan, Yemen, India, Canada, USA, Austria, Denmark, France, Germany, Netherlands, Sweden, UK, Czech Republic, Lithuania, Russia, Switzerland, Slovakia, Australia	kg	11080531	1973302921
Total			11,922,988	2,019,439,243

Source: Statistical Information on Nepalese Agriculture, 2013/14 MoAD

Table 4: Import FY 2013/14

Types	Importing Partners	Unit	Quantity	Value (NRs)
1. Green tea not fermented in immediate packaging	China, Japan, Thailand, India	kg	640	578130
2. Green tea not fermented	China, Taiwan, Thailand, India, USA	kg	1411	1959900
3. Black Tea fermented and partly fermented	China, Lebanon, Sri Lanka, Thailand, UAE, India, USA, Italy, UK	kg	26327	5723983
4. Black Tea fermented	China, Indonesia, Japan, Korea PR, Malaysia, Saudi Arabia, Singapore, Sri Lanka, Thailand, Vietnam, India, South Africa, Cameroon, Italy, UK	kg	270869	47568273
Total			299,247	54,830,286

Source: Statistical Information on Nepalese Agriculture, 2013/14 MoAD

As the production is increasing, the trading partners are also increasing in the global market. However India is the major trading partner till date.

Export Import trend of tea

The graph below indicates the trend of tea export and import in Nepal.

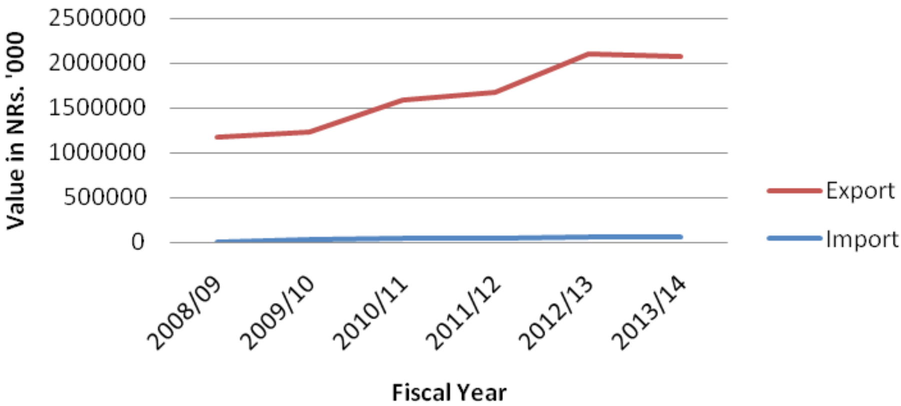

Figure 2: Export Import Trend

In above graph, the value of export is seen more than the value of import. This is somehow positive sign though the share of Nepalese tea in international market. Since the FY 2008/09, the value of export is increasing till 2012/13. In 2013/14, the value of export dropped slightly from NRs. 2.04 billion to Rs. 2.01 billion.

OPPORTUNITIES

Favorable climatic condition for tea cultivation is one the best opportunity for tea development in Nepal. The tea cultivation has been extended in different part of the country which was previously limited only in certain eastern part. There are still many other potential area that could be utilized for further tea expansion. More the cultivation means more the production. This will help increasing present status of export.

In global market, tea exports by country totaled US$ 6,966,226,000 (Nepalese Rs. 696,622,600,000) in 2014, a 7.3 percent increase in value since 2010. It is of course down 10 percent as compared to the value transacted in 2013. Sri Lanka shares 23.1 percent of total export value whereas Nepal shares a total of 0.28 percent only in global export. It is clear that Nepal can increase its share in global market increasing its present volume of export. Therefore, by cashing in the favorable climatic condition, Nepal can produce more tea in the future using land suitable for tea cultivation and increase its volume of export in the global market.

The aroma of Nepalese tea, its blending, taste and color are another strong points associated with tea sector in Nepal. The tea connoisseurs had already been appraised these things. This is good opportunity for Nepal to enter in new global market along with increased shares in existing markets.

Tea sector is also a very good platform for employment generation particularly for rural women employment. It is believed that more than a hundred thousand people are employed in this sector and it could be doubled or more than that in the future. Furthermore, it has also an important sector that helps creating entrepreneurships. There is good opportunity for tea entrepreneurs to enter in this sector which again creates additional employment opportunity.

Beside that it is a good source of revenue for the government. Just one digit tax levy on tea export and domestic sales will generates good revenue to the nation.

CHALLENGES

It is no doubt that Nepal has great opportunity in tea sector from the point of view of employment and income generation. But it does not mean that this sector is free of challenge. There are many challenges that yet to be addressed by the related stakeholders.

It does not matter whether it is in domestic market or external market, quality, quantity and the competitiveness plays a very decisive role. Any buyer wants the seller to supply the product as much as the quantity he or she need in time. "Is Nepal reached in a position to supply as much as quantity the buyers need in time?" is a great challenging question. "Certainly not" is the answer. So, the volume of products is one the great challenges to the Nepalese tea exporters.

Another major challenge is associated with quality matter. Technical Barriers to Trade (TBT) agreement was one of the mandatory obligations of the WTO. Nepal as a member of the World Trade Organization (WTO) must follow the TBT provision. It has sure opened the door for Nepalese products to enter the new markets. TBT protects not only the health, safety and satisfaction of consumers but also present a challenge for export oriented producers. Public health is the most concern of all the developed countries. So, they have given first priority to the public health and they watch strictly on imported goods.

The definition of "safe" consumer goods, necessary protection and their policy differs from one to next country. It is not so easy to Nepalese tea exporters to guarantee the necessary compliances and also very expensive to follow the process. Therefore, the exporters particularly the orthodox tea exporters are seen not so serious in following TBT provisions. In the mean time, an indiscriminate use of chemical pesticides by some producers has caused all Nepalese tea to be scrutinized by importing markets.

Quality Certification is another big challenge in tea sector. In Nepal, there is no internationally recognized laboratory with modern equipment and technology that could test and certify the quality and standard of Nepalese tea. As a result, Nepal has to send the sample tea to Kolkata lab, India to test the quality which is a not only expensive but also time consuming. However, the government effort is continuing for the establishment of such type of laboratory in the country through Department of Food Technology and Quality Control.

Furthermore, price competitiveness is also a great challenge. Due to lack of labor, lack of adequate facilities, old age technology adaptation, and poor infrastructures, the production cost of Nepalese tea is comparatively high. Even in South Asia, there are big tea producers and exporters countries like Sri Lanka, China, India, and Vietnam having better developed packaging and bagging capacity competing in the global tea market. At present situation, it is very difficult for Nepal to compete with them. How to compete with them is a big challenge for Nepalese tea exporters.

In most of the countries, tea trade is done by auction but in Nepal, auction system is not yet introduced. So far the auction system is concerned, it is not so easy to implement in practical. There are still some traders who are not seen that much interested in introducing the system. The volume of production is not enough for auction system. To make auction system successful, the private sector involving tea trades have to accept the auction process though they have to bear loss for the time being. Auction market is necessary to bring together buyers and sellers, and ensure transparency.

CONCLUDING REMARKS

It is already cleared that tea is a potential export oriented cash crop to earn foreign currency with many opportunities to develop this sector. Therefore, both the public and private sectors involving in this sector must be prudent to cash in the opportunities. The state must play the effective facilitators role to promote this sector and the private sector also be encouraged to invest in this sector. The most important fact is to increase the present status of export and its shares in the global market. For this, special priority should be given to improve quality of the product. The exporters also need to bear in mind Sanitary and Phyto-Sanitary (SPS) and TBT requirements in destination markets. If the quality and standard issues are taken seriously by the Nepalese tea traders, Nepal, no doubt, can increase its share in the global market. But, at the same time, the government of Nepal also lobby the WTO to get maximum facilities that a under developed country can received under Trade Related Technical Assistance (TRTA), and Aid for Trade (AfT).

REFERENCES

Nepal trade, Issue # 3, May 2012

General Information about WTO, EU, CNI, CAI, WVAF

Status of Nepalese Tea Trade in Global Market – Ram Krishna Shrestha

Netional Tea and Coffee Development Board, 2014

Krishi Dairy 2015

Statistical Information on Nepalese Agriculture, FY 2013/14, MoAD

Trade and Export Promotion Centre

Tea and Coffee Development Program, Annual Progress Report, FY 2014/15

Fruits Development Directorate, Department of Agriculture

COFFEE AS A NICHE CROP FOR MID-HILLS OF NEPAL

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ABSTRACT

Coffee, the second largest commodity next to petroleum traded in the world market, is produced in more than 100 countries. Brazil is the world leader in production and America in consumption. Coffee, entered Nepal from Burma in 1938 has been extended to about 41 districts in the mid-hills of Nepal with significant potential as export commodity. It is a high value cash crop with environmental importance and is being popular among Nepalese people since last few decades. More than 30,000 small growers have been involved in coffee cultivation in about 1911 ha with 429 tons of green beans production in the year 2014. In line with the focus of periodic plans and policies, the Ministry of Agricultural Development has taken ample initiatives for the promotion of coffee cultivation. Thirteenth plan has also given attention for development of coffee sector as high value crops in the mid-hill regions of Nepal. Respecting the interest of the people on coffee and favorable climatic conditions for its cultivation, development organisations like HELVETAS Nepal are complementing to government organizations in coffee sub-sector development. In Nepal majority of coffee is wet processed and considered better quality coffee. Nepali coffee possesses specialty quality potential; have revealed 82-86 percent specialty quality, thus demand outstrips supplies. Lack of manpower, research on technologies and varieties to increase production and productivity, national policy and plans for promotion of organic and fair trade practices are the areas to review for coffee sub-sector development in Nepal.

INTRODUCTION

Coffee is one of the prestigious soft drink. It is the second largest commodity traded in the world market next to the petroleum product, and producing in more than 100 countries. Being such high profile statistics it is well-known by "Brown Gold" in the world community. Brazil is the number one leading country in terms of production whereas USA is higher coffee consuming country and per capita coffee consumption is highest (12 kg/person/year) in Finland.

In 9th century, an Ethiopian shepherd discovered coffee when he noticed his goats excited after eating the coffee beans. Thus, the origin country of domesticated coffee plant is known as East Africa "Ethiopia".

All coffee plants are classified in the botanical family Rubiaceae. They are evergreen shrubs. Several species of shrub of the genus Coffea produce the berries from which coffee can be extracted. There are four species: arabica, robusta, excelsa and liberica. However, two main species are commercially cultivated i.e., Coffea arabica and Coffea robusta. In these two species of Coffea, the finest quality being arabica, which today represents 70% of the world's coffee production (www.coffea arabica Wikipedia). All introduced and cultivated coffee cultivars in Nepal are Coffea arabica which is regarded as Highland Himalayan special coffee. Chemically, the caffeine content of C. arabica varies from 0.9 to 1.7% of each bean's volume (www. Coffea arabica Wikipedia).

Hira Giri, who is known as the pioneer of coffee introduction in Nepal in 1938 AD (www.teacoffee.gov.np), brought few seeds of coffee from Sindhu Province of Burma (Now Myanmar) through India and planted in Aanpchaur, Gulmi. Thus, Gulmi stands for the first coffee growing district in Nepal. Thereafter coffee extended as a curiosity plant for about four decades.

In late Seventies, coffee commercialization got momentum to some extent when Tinau watershed Programme planted coffee as soil conservation crop in Palpa and Government of Nepal imported coffee seeds from India for distribution to the farmers. In 1983/84, Nepal Coffee Company (NeCCo) was established in Manigram, Rupandehi district. This was the milestone to the coffee commercialization in Nepal. Then, the coffee producers were able to sell their produce to the company. Until early 2000, coffee producers were not sure of coffee being a source of income or income generating crop due to the market problem. However, after the year 2002, substantial increase in the export and also increase in domestic market consumption to some extent motivated coffee producers to consider coffee as a major income generating crop (www.teacoffee.gov.np). At present Nepal's coffee has its own brand, due to organic produce and persist special taste, aroma and flavor, it has own dignity in the world coffee consuming society. In

Nepal, coffee is grown commercially in 24 districts amongst 41 potential mid-hill districts.

IMPORTANCE

Coffee is playing very important role in Nepalese economy, agriculture and environment. It is high value crops in terms of economy and export status. Being imperishable commodity by nature, coffee can be grown in remote areas by rural people in groups or cooperative model. These activities definitely help to reduce rural poverty and increase income of rural people and generate employment opportunities. The importance of this crop is briefly discussed as follows:

Nutritional value

The primary chemical available in coffee beans is caffeine "$C_8H_{10}N_4O_2$", which is a special safe chemical that stimulate the central nervous system (CNS). The coffee beverages are very popular; in USA, 90% of adults consume coffee daily. A cup of coffee contains 80-175 mg of caffeine, depending on what "bean" (seed) is used and how it is prepared (www.caffeine Wikipedia). It is reported that regular consumption of black coffee reduces cholesterol level of blood and persist antioxidant properties in coffee drink which has multiple positive impact in human health. However, it depends on the physiology of an individual.

Economic value

Coffee is planted on marginal uplands where single crop of maize and in few cases second crop of millet planted. The study reported that in comparison to maize and millet, net return from coffee cultivation is 4.33 times higher than maize, 3.30 times higher than millet and 1.87 times higher than maize followed by millet cultivation (CoPP, 2009). In Nepalese context, coffee plantation is under the shade of multipurpose trees, which provides shade as well as their own produce. It can aid 10-15% additional income (NTCDB, 2013).

Employment opportunity

Coffee, as a perennial shrub, need series of work on production, processing and marketing and requires a lot of technical and skilled human resources. Coffee value chain starts form cherry picking to final cup, which involves different steps such as picking/harvesting - pulping - hulling - roasting - grinding - packaging - brewing etc. Every step adds value. This contributes to employment opportunity and income generation for rural youth and reduces labor migration.

Environmental benefit

Nepal is hilly region and topography of land in Nepal is too steep. Nepalese hills are prone to land slide during monsoon (Paudel, 2009). In steep slope, ever green vegetation like coffee plantation is very much helpful for soil and environment conservation and ecological balance. Coffee farming is done in the shade of trees, which provided natural habitat for many animals and insects, roughly approximating the biodiversity of a natural forest. Coffee plant is also bird friendly and during flowering period it attracts the honey bees; good source of nectar. It is a good source of oxygen (O2), which produces 37 kg of O2 per ha per day (www.ico.org).

Import substitution and export promotion

It is rectified that Nepalese organic coffee can compete world coffee market due to its premium quality. The demand for Nepalese coffee is increasing at national and international market. Major portion of Nepalese coffee is exported to more than 20 countries where Korea, Japan, Europe and USA are the major ones (www.tepc.gov.np).

SCOPE OF COFFEE CULTIVATION IN NEPAL

Owing to the prevalence of unique microclimate and organic produce, Nepalese coffee has classic quality: taste, aroma, and flavor, which shows the high potential of coffee cultivation in Nepal. In the context of comparative advantage and growing international demand of specialty Nepali coffee, it is high time to consider commercialization of this high value commodity from all sectors including government, donors, investors and coffee stakeholders. The scope of this crop examines in this paper as follows.

Potential area and production

There are 41 potential districts in the mid-hill region of Nepal where 1.1 m.ha of land is potential for coffee (MoAD, NTCDB, 2014). Hills have unique micro environment in very short vertical distance (Paudel, 2009). Such micro climate variation favors comparative advantage of growing different niche base crops. Land may not be the limited resource for coffee production in Nepal. Sloppy and marginal land somehow degraded land; community forest also can be used for coffee plantation by using soil amendment. Among total area of Nepal, mid-hill occupies about 42 percent of land (MoAD, 2014) with altitude ranges from 800 to 1500 meter above mean sea level majority of which can be brought under coffee cultivation. Present production is at 429 ton Green Bean which can be increased by 1000 times.

Sustainable farming

Climate change is another new challenge to the sustainable farming system in the mid-hills. Ever green shrub like coffee plantation could be the best option for mitigation and adaptation activity. Coffee growing and processing needs water, which can be managed properly in mid-hills of Nepal. Being imperishable commodity, people from remote area can also grow coffee in groups or cooperative model and coffee cooperatives are taking lead throughout the value chain of coffee with fair trade principle.

Specialty quality

Coffee in Nepal is grown in altitude ranges from 800-1500m msl for specialty highland coffee. Being grown in hilly region, away from the Mediterranean region; it possesses specialty quality different to other major coffee growing countries. Nepali coffee offers specialty taste to the consumers because it is Arabica only, grown with organic practice under shade above 800 m from mean sea level.

Organic and fair trade

Organic and fair trade coffee has high demand at both national and international markets, for which Nepal has high scope/ potential because 100 % of Nepali coffee is considered as by default organic and many of the cooperatives have practices fair trade principle.

Youth employment

Coffee involves several activities from seed to cup. Farmers' involvement in planting to cherry harvest, pulping and preparation of Parchment is followed by, traders' involvement in trading of parchment or green beans, coffee roasting, grinding and brewing imply scores of business. These series of value chain process definitely requires different human and financial resources, which in due course create employment opportunities to Nepalese youth.

Agro-tourism

Different distinctive features of mid-hills of Nepal like famous Annapurna trekking route, habitat of diverse ethnic and tribal communities, availability of different flora and fauna make them a very potential domain for agro-tourism. Like tea garden in Eastern Nepal, coffee plantation in Central and Western hills can promote tourism industry by catching the attention of domestic as well as foreign tourists from different countries visiting to Nepal.

Organized institutions

Good and well setup organizational structures also help in coffee promotion in Nepal. Ministry of Agricultural Development (MoAD), NARC, National Coffee Producer Association (NCPA) and different private sectors/INGOs like Coffee Promotion Programme, HELVETAS Swiss Inter cooperation Nepal (CoPP), IDE, Winrock International, Good Neighbor International, JICA are involved in production and trading, which eventually continue their support in coffee sub-sector development.

DEVELOPMENT OF COFFEE SUB-SECTOR IN NEPAL

To coordinate the coffee development in the country, Government of Nepal (GoN) established Tea and Coffee Development Section under Fruit Development Directorate of the Department of Agriculture in 1993. Likewise, National Tea and Coffee Development Board was also established under the National Tea and Coffee Development Board Act (1993). Some INGOs like Coffee Promotion Programme, HELVETAS Swiss Intercooperation Nepal (CoPP) is supporting the coffee farmers since 2003 in 12 districts. Similarly, JICA, IDE, Winrock International, Good Neighbor International are also supporting in coffee sub-sector development. As a genuine process of promoting Nepalese coffee, the GoN has approved Nepali Coffee Logo (Figure 1). Brief historical events of the development in the coffee sub-sector are listed in Table 1. Considering the prominence of high value crops, GoN has promulgated/ formulated some agricultural policies, and plans for the promotion of production, processing and marketing of high value crops including coffee.

Figure 1: Nepal Coffee Logo

Policies, Plans and Programs for promoting Coffee

Some of the policies that have emphasized promotion of coffee are as follows.

Agriculture Perspective Plan(APP) (1994/95-2014/15) recognised coffee as potential high value and exportable commodity. It was further emphasised in the Ninth Five Year Plan (1997-2002). Tenth Five Year Plan (2002-2007) targeted to increase the production of coffee and focused on production support on coffee and started to give 50% subsidy on the samplings (NPC, 2002). The Coffee Policy, 2004 paved the way of coffee sub-sector involving the private sectors, NGOs, cooperatives and other members based organizations for promoting the production, processing and marketing of coffee in a sustainable and organized way. The policy has emphasised import substitution and export (MoAD, 2004).National Agricultural Policy (NAP), 2006highlighted significantly for fostering coffee as high value crops in the mid-hill regions.Agricultural Biodiversity Policy, 2007organic production like coffee (MoAD, 2006).Agri-Business Promotion Policy (ABPP), 2007 stated need for developing the organic certification of the products, including coffee.

National Technical Standard for Organic Agriculture System (NTSOAS), 2008further cleared the way for promoting the organic production and processing of high value agricultural products like coffee.

Three Years Interim Plan (2007-2010)included the coffee, among other 22 valuable commodities, as a priority commodity for income generation. Three Years Plan (2010-2013)emphasized mid-hill areas for the promotion of coffee production and gave importance for the conversion of Nepalese coffee into Highland Organic Coffee. This plan included support for the value chain development, technology transfer, agri-market information system development and agriculture entrepreneurships expansion for coffee and coffee export facilitation as well. Thirteenth Plan (2013-2016) gave attention for development of coffee sub-sector as high value crops in the mid-hill regions.

Table 1: Chronological history of coffee research and development in Nepal

Year	Event
1938	First time introduction of coffee in Aanpchaur, Gulmi, Nepal.
1968	HMG/Nepal introduced some varieties from India and distributed to the farmers of Gulmi, Palpa and Arghakhanchi.
1981	First commercial coffee nursery established in Aanpchaur, Gulmi.
1982	Tinau Watershed Project (TWP) and Palpa Development Project (PDP) planted coffee as soil conservation crop in Palpa.
1983	Nepal Coffee Company (NeCCO), first coffee mill in Nepal, established in Manigram, Rupandehi.
1984	Establishment of Coffee Development Centre in Aanpchaur, Gulmi.
1989	Initiation of organic coffee production in Madanpokhara, Palpla.
1990	Formation of Coffee Producers Group in Madanpokhara, Palpa.
1991	Registration of Nepal Coffee Producers Association in Palpa.

Year	Event
1993	Establishment of Tea and Coffee Development Section under Fruit Development Directorate of the Department of Agriculture.
	Establishment of National Tea and Coffee Development Board under the National Tea and Coffee Development Board Act, 1993.
1994	First recorded export of green beans (dry processed) to Japan.
1995	Establishment of Regional office of NTCDB in Palpa.
	Coffee Varietal Evaluation in ARS (Hort.) Malepatan by Lumle Agriculture Research Center, Kaski.
1996	Local Initiatives Support Programme (LISP) extended coffee through Nepal Coffee Producers Association (NCPA) in Palpa.
	Organic Certification of coffee under District Cooperative Federation, Gulmi.
1998	First training on organic coffee production organized by LISP, HELVETAS and FtF Program, Winrock International at Madanpokhara, Palpa.
	Formation of Central Committee of Nepal Coffee Producers Association (NCPA).
	HELVETAS Swiss Inter cooperation Nepal/ Winrock International introduced and distributed coffee varieties (Pacas, Pacamara, Tekisic, Ketisic) in different farms and stations.
	Registration of Nepal Coffee Producers Association at National Level.
1999	SSMP in collaboration with NCPA initiated coffee related activities in Syangja, Parbat, Kavre and Sindhupalchowk.
	Introduction of wet processing technology (11 pulpers from India) by AEC to introduce wet processing in Nepal.
2000	Establishment of Highland Coffee Promotion Company in Kathmandu.
2002	Initiation of coffee FFS in Palpa, Parbat, Syangja, Kavre and Sindhupalchowk (LISP/NCPA)
2003	Coffee Promotion Program initiated by CoPP, HELVETAS.
	First time NTCDB fixed dry cherry price based on the quality (three grades) of dry cherries.
	Introduction of wooden Hand Pulper from Indonesia by Holland Coffee Inc.

Year	Event
2004	National Coffee Policy implemented. NARC, DOA, Nepal Tree Crop Global Development Alliance initiated coffee study in Panchkhal farm, Kavre. Tea and Coffee Development Section was reorganized into Coffee and Tea Development Section with increased program thrust on coffee and additional manpower.
2005	Central Coffee Cooperative Union established. Agriculture Research Station (Hort.) and National Tea and Coffee Development Board started organic manure experiment. First training on Internal Control System (ICS) and Internal Inspection conducted at Gulmi by CoPP, HELVETAS
2010	Nepal Coffee Logo approved by the Government of Nepal. Establishment of Field Gene Bank of coffee in ARS (Hort.), Malepatan, Kaski.
2014	Establishment of Coffee Research Program in Baletaxar, Gulmi.

PRESENT STATUS OF COFFEE IN NEPAL

Coffee Varieties and Nursery

There are two main varieties of coffee being cultivated i.e., Arabica (C. arabica) and Robusta (C. canephora). Of the two main species, Arabica coffee is grown at higher elevations, produces better beans and has good quality. So, at present only this variety is cultivated in Nepal and is being preferred because of its quality. A number of varieties of Arabica coffee has been collected and planted in the Horticultural Research Station, Malepatan, Pokhara. But locally collected materials have not been analyzed at molecular level. Different varieties and their characteristic features are presented in the Table 2.

Figure 2: Coffee Nursery

Arabica coffee is most commonly grown from selected seed to raise seedlings in nurseries. A number of steps are being followed for production of good seedlings i.e., selection the seed, starting the nursery, build nursery shelter and seedbeds, and finally planting the seed. Depending on temperature, coffee seedlings are ready to be transplanted from the nursery bed into poly-bags about two to three months after sowing following some steps in the process i.e., preparing the potting mixture, selecting the seedlings, planting seedlings in bags and caring for the seedlings (Figure 2).

Table 2: Coffee varieties and their major phenotypic characteristics

SN	Varieties	Major qualitative and quantitative characteristics
1.	Arghakhanchi Local	Collected from Arghakhanchi district in 2010, trees are tall, new shoots are green whereas ripe cherries are red in color, very good performance in mid hill condition, 100 fresh ripe cherries weight is 150 gram.
2.	Bourbon Amarillo	Trees are medium tall, new shoots are green whereas ripe cherries are yellow in color. 100 fresh ripe cherries weight is 136 gram.
3.	Bourbon Vermello	Trees are tall, new shoots are copper color whereas ripe cherries are red. 100 fresh ripe cherries weight is 148 gram.
4.	Cattuai Amarillo	Trees are medium tall, new shoots are green whereas ripe cherries are yellow in color. 100 fresh ripe cherries weight is 150 gram.
5.	Cattuai Vermelo	Trees are medium tall, new shoots are green whereas ripe cherries are red in color. 100 fresh ripe cherries weight is 128 gram.
6.	CatturaAmarillo	Trees are medium tall, new shoots are green whereas ripe cherries are yellow in color. 100 fresh ripe cherries weight is 150 gram.
7.	Cattura Vermello	Trees are medium tall, new shoots are green whereas ripe cherries are red in color. 100 fresh ripe cherries weight is 146 gram.

SN	Varieties	Major qualitative and quantitative characteristics
8.	Catimore	Hybrid cultivar (Catimore X Timor) developed in Brazil. Robusta gene also incorporates in this cultivar (NTCDB, 2013). Trees are medium tall, new shoots are green whereas ripe cherries are red in color. 100 fresh ripe cherries weight is 148 gram.
9.	Chhetradeep	Collected from Deep, Kaski district. Trees are medium tall, new shoots are green whereas ripe cherries are red in color. 100 fresh ripe cherries weight is 148 gram. Very good perform in mid hill condition.
10.	Hawai Kona	Trees are tall, open type tree, new shoots are copper color and ripe cherries are red in color. 100 fresh ripe cherries weight is 150 gram.
11.	Indonesia	Trees are tall, open type tree; new shoots are copper color whereas ripe cherries are red. 100 fresh ripe cherries weight is 146 gram.
12.	Indo Timtim	Collected from Puranchaur, Kaski district. Trees are medium tall, new shoots are green whereas ripe cherries are red in color.
13.	Kaski Local	Trees are tall, open type tree; new shoots are green whereas ripe cherries are red in color. 100 fresh ripe cherries weight is 152 gram.
14.	Ketisic	Selected from Catimore cultivar in El-Salvador. Trees are tall and open type tree, new shoots are copper in color and ripe cherries red. 100 fresh ripe cherries weight is 120 gram.
15.	Mundo Novo	Trees are tall, open type tree; new shoots are green whereas ripe cherries are red in color. 100 fresh ripe cherries weight is 112 gram.
16.	Pacas	This cultivar was developed through natural mutation from cultivar Bourbon. Trees are medium tall, dense tree and leaves are long, wide and shiny. New shoots are copper color whereas ripe cherries are red and large in size. Very late maturing (March/ April) in Pokhara condition. 100 fresh ripe cherries weight is recorded 176 gram.

SN	Varieties	Major qualitative and quantitative characteristics
17.	Pacamara	This cultivar was developed through crossing up to four progeny between Pacas and Redmaragojipka in El-salvador. Trees are medium tall dense tree and leaves are long, wide and shiny and new shoots are copper color whereas ripe cherries are red and large in size. Very late maturing (March/April) in Pokhara condition. 100 fresh ripe cherries weights is 247 gram.
18.	Puranchaur Local	Collected from Puranchaur, Kaski district. Trees are tall, new shoots are green whereas ripe cherries are red in color.
19.	Sanroman	Collected from Coffee Development Center Aanpchaur, Gulmi in 2012. Trees are dwarf and open type cultivar. Young shoots are copper color whereas ripe cherries are red. Useful for high density planting system. Ripe cherries are red in color.
20.	Selection-10	Cultivar developed by crossed among Cattura X other arabica varieties in India (NTCDB, 2013). Trees are tall and open type tree with long branches with long internodes. New shoots are copper color whereas ripe cherries are red in color. 100 fresh ripe cherries weight is 148 gram. Very good perform in western mid- hill condition.
21.	Syangja Special	Collected from Karendanda, Syangja district in 2004. Trees are medium tall, new shoots are green whereas ripe cherries are red in color. 100 fresh ripe cherries weight is 151 gram.
22.	Tekisic	This cultivar was developed from mass selection procedure in El Salvador during 1949-1957. Trees are tall, new shoots are green whereas ripe cherries are red in color. Very good perform in western mid-hill condition. 100 fresh ripe cherries weight 146 gram.
23.	Yellow Cattura	Trees are medium tall, new shoots are green whereas ripe cherries are yellow in color. 100 fresh ripe cherries weight 118 gram. Very good perform in western mid-hill condition.

Source: KC, R.B. 2014.

Coffee Farming

Nepal produces coffee in one of the highest elevation in the world. Coffee farming in Nepal is proven as promising due to the availability of soil with appropriate climate in the mid-hills at an altitude of 1000 meter and above where these areas get fresh and cool wind from Himalayas that is suitable for high grown specialty coffee. There are procedures which are followed in farm management i.e., preparing the land, planting windbreaks, marking out the rows, establishing shade trees. To achieve high yields of quality coffee, trees are protected from frost, weeds are controlled, plants are mulched and watered. Pruning is done to supply good healthy wood for the next season's crop, maintain the correct balance between leaf area and crop, prevent overbearing and dieback, reduce biennial bearing and maintain good tree shape. The plant can tolerate low temperatures, but not frost, and does best with an average temperature between 15 and 24 °C (Figure 3).

Figure 3: Coffee orchard

Coffee Production

Coffee is commercially produced in many parts of the country. At present, there are altogether 24 districts growing coffee commercially. The major coffee growing districts, where considerable amount of coffee is being traded, lie in Central and Western Development Regions namely Gulmi, Palpa, Arghakhanchi, Baglung, Syangja, Parbat, Kaski, Lamjung, Gorkha and Tanahu in the Western Region and Lalitpur, Sindhupalchowk, Kavre, Dhading, Nuwakot and Ramechhap in Central Development Region.

Most of the coffee producers grow coffee in small scale with 100-150 plants.Insome districts farmers have grown coffee in maximum of 0.4 hectare areas. Besides area coverage and production, the productivity of Nepalese coffee is also comparatively lower than the productivity of other countries.

In the fiscal year 2013/14, total area under coffee cultivation was 1911 hectares with total production of 429 MT Green Beans and 30,543 local farmers (Table 3) were engaged in this sector (MoAD, 2014).

Table 3: District-wise plantation area, production and yield of coffee, 2013/14

S. No.	Districts	Area (ha)	Green beans production (MT)	Yield (kg/ha)	Farmers (No.)
1.	Syangja	262	45.3	173	3,110
2.	Kavre	155	36.0	232	3,200
3.	Gulmi	143	36.4	255	1,760
4.	Nuwakot	136	31.5	232	1,173
5.	Kaski	122	28.0	230	4,000
6.	Lalitpur	120	31.5	263	975
7.	Arghakhanchi	110	25.0	227	1,600
8.	Lamjung	110	16.0	145	1,300
9.	Palpa	100	24.2	242	2,250
10.	Sindhupalchowk	96	28.5	297	1,535
11.	Parbat	75	11.5	153	1,875
12.	Dhading	60	15.0	250	700
13.	Baglung	55	13.0	236	1,330
14.	Ilam	52	16	308	600
15.	Panchthar	40	10	250	415
16.	Rasuwa	38	5.5	145	350
17.	Gorkha	35	7.0	200	700
18.	Tanahu	27	16	145	1,300
19.	Makwanpur	26	9.5	365	800
20.	Myagdi	25	6	240	470
21.	Sankhuwasabha	25	5.0	200	355
22.	Pyuthan	22	7	318	400
23.	Khotang	15	4	267	250
24.	Bhojpur	9	2	222	145
25.	Other 15 districts	53	11.5	217	650
	Total	1,911	429.4	225	30,543

Source: MoAD, 2014

As per official statistics, the area under coffee was 136 ha in 1994/95 which increased to 1911 ha in 2013/14 (Table 4). Similarly, the production of coffee increased several times since then (NTCDB/ MoAD, 2014).

Table 4: Coffee plantation area, production and yield in Nepal on different years

S. No.	Fiscal Year	Coffee Plantation Area (ha)	Coffee Production (kg)			Yield (kg/ ha)
			Dry Cherry	Dry Parchment	Green Beans	
1.	1994/95	136	12950			95
2.	1995/96	220	29200			133
3.	1996/97	259	37350			144
4.	1997/98	272	55900			205
5.	1998/99	277	44500			161
6.	1999/00	314	72400			230
7.	2000/01	424	88700			209
8.	2001/02	596	139200			234
9.	2002/03	764	187500			245
10.	2003/04	952	217500			228
11.	2004/05	1078	250000			232
12.	2005/06	1285	391000			304
13.	2006/07	1296		270000		208
14.	2007/08	1450		265000		183
15.	2008/09	1531		334000		218
16.	2009/10	1630		429000		263
17.	2010/11	1752			401500	229
18.	2011/12	1760			410000	233
19.	2012/13	1750			366000	209
20.	2013/14	1911			429400	225

Source: NTCDB, Nepal. MOAD, 2014

Coffee Harvesting

Harvesting of coffee is usually done once in a year. The time varies according to geographic zone but in Nepal harvesting starts in November and completes in March. Harvesting is done selective picking by hand (Figure 4) when about 5% of the cherry ripe and is termed as fly picking. And main picking starts after 50 % of the cherry gets ripe. Selective picking is done in Nepal which helps in maintaining high quality of coffee.

Coffee Processing

Coffee cherries are processed immediately after harvest. There are mainly two types of processing in practice: (a) Dry-Process, (b) Wet-Process.

Figure 4: Picking of ripe cherry

(a) Dry-Process: It consists of drying selected cherries in the sun until the moisture comes down to 11 percent. The dry-process (also known as the natural method) produces coffee that is heavy in body, sweet, smooth, and complex.

(b) Wet-Process: This is a relatively new method of removing the four layers surrounding the coffee bean. This process results in a coffee that is cleaner, brighter, and fruitier. This method consists of following steps:

(b1) Pulping Coffee: In this step, coffee cherries are dipped in the water which is kept in a bucket. Undeveloped coffee cherries, sticks and leaves, float in water, are removed. The matured and good cherries sink in the water. Pulping should be done within 12 hours of harvest. It prepares parchment (Figure 5).

Figure 5: Pulping ripe cherry

(b2) Fermentation and Washing: The Parchment is covered with the slippery mucilage. Fermentation is done for 12-48 hours depending on the water temperature and humidity to remove the mucilage. Fermentation should be done in nonmetallic container like plastic, wooden bucket. Then the parchment is washed in clean water until the mucilage is completely removed.

(b3) Coffee Drying: Washed coffee parchment of about 60% moisture is moved to pre-drying net. It can be made up of bamboo mat or steel wire mesh. Until the water is drained, the parchments are moved to drying yard /patios and dried in the sun to 11-12% moisture content.

Hulling

Dry parchment is hulled in a hulling machine which removes silver-skin and prepares Green bean.

Sorting Coffee Beans

Color sorting is frequently used to remove the defective coffee beans that were not removed during coffee processing or hulling (Figure 6).

Figure 6: Sorting coffee beans

Storing Green Coffee Beans

Coffee must be stored in dry and cool conditions. Exposure to the sun or moisture will rapidly deteriorate the coffee. Burlap or jute bags are often used for coffee bean storage because they allow air flow. They also preserve the coffee longer than plastic or paper bags. Burlap bags should be aired on the patios before storing coffee to prevent a baggy flavor or burlap scent from being imparted to the coffee.

Coffee Roasting

Coffee roasting is a process which creates or balances the aroma, acidity, aftertaste, bodyand other flavour components. Roasting at local level can be done in a ceramic pot or fry pan in a mild and constant heat. Roasting is generally done at three levels depending upon the personal taste and of choice: light, medium and dark. It should be done until the beans take on an oily sheen (Figure 7).

Figure 7:Roaster

Grinding Coffee Beans

For proper extraction, it is essential to grind coffee properly. Freshly grinding the beans before brewing coffee is one of the most important steps for achieving a quality cup of coffee. Coffee grind just before brewing gives better taste. Grinding coffee depends on coffee brewing method:

Drip coffee requires a medium size grind, espresso requires a fine size grind, and a French press requires the largest grind size while the vacuum pot also requires the largest grind size.

Figure 8: Grinder

At household level, a small hand operated grinder can be useful to meet the need at the household level (Figure 8).

Coffee Brewing

Brewing coffee is as much of an art and methods of brewing are culturally dependent. Some of the common brewing methods are:

Espresso: It is a strong decoction of coffee with a full-flavored, concentrated form of coffee. It is made by forcing pressurized, hot water through very finely grind coffee beans (Figure 9). This process is called "pulling a shot."

Café Americano: Café Americano is a type of coffee created by adding hot water to espresso (Figure 10).

Coffee Latte: Latte is a coffee based drink made primarily from espresso and steamed milk. It consists of one-third espresso, two-third heated milk and about 1 cm of foam (Figure 11).

Figure 9: Espresso

Figure 10: Café Americano

Figure 11: Latte

Coffee Marketing

Nepalese Highland and organic coffee is known in the international markets owing to its high quality cupping and sound aroma (Poudel et al., 2009). Around 25 percent of the production is exported. Sales in the domestic market are also increasing and the present sale is about 75% of the total production. There are about six to eight companies including cooperatives exporting coffee to different destinations. Nepal is exporting coffee beans mostly to Korea, Japan, America and European countries. This has been extended to other parts of the world, too. The data shows (Table 5) that in recent years export volume is decreasing, which indicates that the national consumption is increasing. Likewise import, in terms of value, is also in decreasing trend which helps in balancing trade deficit (NTCDB, 2014).

Table 5: Coffee export and import on different years

S. No.	Fiscal Year	Exports (Green Beans)		Imports (Rs. '000)
		Quantity (kg)	Value (Rs. '000)	
1.	1994/95	14660	1643	18232
2.	1995/96	5040	638	23832
3.	1996/97	4245	6023	15316
4.	1997/98	2000	318	16264
5.	1998/99	3160	634	32471
6.	1999/00	4254	1415	36437
7.	2000/01	3677	673	43200
8.	2001/02	9075	2455	4621
9.	2002/03	16861	5205	142
10.	2003/04	24295	5947	410
11.	2004/05	35677	10792	168
12.	2005/06	91500	27678	2265
13.	2006/07	100180	40117	56000
14.	2007/08	54621	22046	64481
15.	2008/09	508592	125108	11651
16.	2009/10	69044	24363	54400
17.	2010/11	279762	93089	12513
18.	2011/12	109442	43095	20894
19.	2012/13	99303	53009	32771
20.	2013/14	66461	52395	34816

Source: NTCDB, Nepal, MoAD, 2014.

Major Stakeholders

Nepal Coffee Producers' Association (NCPA) record shows that more than 30,000 farmers are cultivating coffee in Nepal. Apart from coffee growers there are several individual and organizations involved in coffee processing, trading and export. Of the eleven institutions involved in coffee processing and trade, two are cooperatives and remaining 9 are registered as companies. Four of them supply to domestic market and to exporters while six of them export coffee in addition to supply to domestic markets. A list of registered coffee processor and traders can be found in Annex 1.

OPPORTUNITIES

- High quality coffee can be produced in Nepal;
- There is increasing trend in consumption both at national and international market;
- It generates significant income for farm household (upland);
- Organic production methods are compatible with existing farming practices (No yield reduction in conversion);
- There is easy integration of coffee into existing farming systems;
- Coffee producers are organized at village, district and central level;
- Trade relationships are established with international buyers, long term trading relationships with Fair Trade buyers in Europe / Korea;
- Several certifying agencies are active in Nepal;
- There is strong organizational setup;
- Many stakeholders like producer groups/associations, processor/traders, INGOs/NGOs, GOs, World Bank are involved in organic coffee promotion;
- National Organic Standard have been developed and approved by GoN;
- Government funds are available for external inspection and organic certification.
- Nepal coffee logo is approved and awarded to three processors/traders.

ISSUES AND CHALLENGES

- Identification of location specific high yielding varieties: There is Lack of varietal option for different elevation. Although some research has initiated, high yielding domain specific coffee cultivars still not been recommended and released.
- Biotic/aboitic stresses: Even if several insect species have been recorded, Xylotrechus quadripes (Coleoptera: Cerambycidae), the coffee white stem borer is the most serious pest of arabica coffee in Nepal (Bajracharya, A.S.R., 2015). Low soil fertility and moisture stress during summer are the major yield limiting abiotic factors.
- Poor technical know-how: There is lack of trained human resources. Both production and post-production technical know-how is extremely lacking among the coffee producers.
- Demand surpass production: Present production of 429 ton has not been meeting the demand of about 6000 ton of coffee beans in the domestic and international arena.
- Quality inconsistency: At processing levels due to poor infrastructure like water, pulping centers, and storage facilities, the quality of coffee is inconsistent.
- Change in consumption pattern: The instant coffee has occupied the taste of coffee among the people. There is the challenges to ascertain the taste of Nepalese filter coffee as a substitute of instant coffee.

WAY FORWARD

- Promotion of coffee shops and consumption of Nepali filter coffee.
- Develop and establish systems to ensure the reputation of Nepali coffee in international speciality markets (Nepal coffee logo).
- Enhance the processing practices with quality consistency.
- Strengthen research throughout the value chain (seed to cup).
- Enhance area, production and productivity to meet the increasing demand.
- Increase collaborative approach/efforts of all the stakeholders involved in coffee sub-sector.
- Promotion of organic and fair trade practices all levels of value

chain.

- Clarity of roles and responsibilities of the stakeholders.
- Deployment of right man to right position.
- Develop human resource on coffee sub-sector.

REFERENCES

ABSD. 2013/14. Statistical Information on Nepalese Agriculture, GoN/MoAD. Agri-Business and Statical Division, Singh Durbar, Kathmandu.

Bajracharya, A.S.R., Y.P.Giri, S. Bista, R. P. Mainali. 2015. Coffee Promotion Strategies Focusing on White Stem Borer Management in Nepal. Organized by Entomology Division, NARC in Technical Collaboration with USAID funded Asia Farmer to Farmer program, Winrock International.

Coffee Promotion Program 2011. Annual Plan 2011. CoPP, Helvetas, Kathmandu.

Coffee Promotion Program 2010. Annual Report 2010. CoPP, Helvetas, Kathmandu.

KC, R. B. 2014. Bagwanika Unnat Prabidhiharu. Nepal Agricultural Research Council. Agriculture Research Station, Malepatan, Pokhara.

NTCDB 2013. Prangarik Coffee Sahyogi Pustika. National Tea and Coffee Development Board, New Baneswor, Kathmandu.

Paudel, M.N. 2009. Prospect and Limitation of Hill Agriculture System in Nepal. Proceeding of Regional Workshop on Hill Agriculture in SAARC countries: Constraints and Oppertunities. SAARC Agriculture Center, BARC Complex, Dhaka, Bangladesh.

Paudyal, K.R. 2011. Review of the Coffee Sub-Sector in Nepal. Proceeding of National Workshop on Coffee Sub-Sector. PACT, Kathmandu, Nepal.

Tiwari, K.P. 2010. Agricultural Policy Review for Coffee Promotion in Nepal. The Journal of Agriculture and Environment, Vol:11, June 2010.

www.coffee Wikipedia.

www.coffea arabica Wikipedia.

www.caffeine Wikipedia.

www.coffee Encyclopedia.
www.cofferesearch.org/coffee/history.htm
www.ico.org
www.nationalgeographic.com/coffee/frame.html
www.teacoffee.gov.np.
www.tepc.gov.np

Annex1: Major Coffee Processors and Traders of Nepal

S. No.	Processor/Traders	Brand Name	Market
1.	Plantec Nepal Incorporated (P) Ltd., Kathmandu, Nepal. URL: www.plantecnepal.com	Jalpa Gold (for regional sales) and Mount Everest Supreme (for export)	Export and Domestic (Roaster)
2.	District Cooperative Federation Ltd., Coffee Purification Centre, Johang, Gulmi	Gulmi Organic Coffee	Export and Domestic (Roaster)
3.	Royal Everest Coffee Mills, Keshar Mahal, Kathmandu, Nepal	Everest Filter Coffee	Export and Domestic (Roaster and Brewer)
4.	Highland Coffee Promotion Co. Ltd., Narephant, Koteshwor, GPO Box: 21037, Kathmandu, Nepal	Him Café	Export and Domestic (Roaster)
5.	Buddha Organic Coffee Industries P. Ltd., Kirtipur-2, Kathmandu, Nepal	Buddha Organic Coffee	Export and Domestic (Roaster)
6.	Kathmandu International Coffee House, Himalayan Java, Kathmandu, Nepal	Himalayan Java	Domestic (Brewer)
7.	Nepal Organic Coffee Products, Madanpokhara, Palpa, Nepal	Morning Fresh	Domestic (Roaster and Brewer)
8.	High Mountain Organic Coffee (P) Ltd., Bhaisepati, Saibu-3, Lalitpur, Nepal	Organic Coffee	Domestic (Roaster)
9.	Shiva Agro Tourism Private Ltd., Pokhara, Nepal	Himal Coffee	Domestic (Roaster)
10.	Gaurishankar Organic Coffee Industry, Panchkhal, Kavre	Gaurishankar Coffee	Roaster and Brewer
11.	Coffee Cooperative Union, Lalitpur	Lalitpur coffee, Jureli coffee	Export and Domestic (Roaster)

Source: Office record of Coffee Promotion Program, Helvetas, Nepal

MEDICINAL AND AROMATIC PLANTS IN NEPAL (A HORTICULTURAL PERSPECTIVE)

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ABSTRACT

Medicinal and Aromatic plants (MAPs) are important natural resources of Nepal. MAPs are used as medicines since the dawn of human civilization. In recent days the use of these resources is diversified and this situation has created big demand and become sources of income to Nepalese people dwelling in remote areas. Most of the market share of MAPs trade comes from wild collection. Therefore domestication and farming practices are to be done. Nepal is just a beginner in domestication and farming of MAPs. It is therefore timely to look into MAPs from horticultural perspective. MAPs cultivation should be emphasized in harmony with their natural habitats based on agro-ecological zones. Research and development in this aspect is necessary.

INTRODUCTION

Plants have been important sources of food, shelter, and clothes to human beings since the dawn of human civilization. Medicinal use of plants also seems to have been developed currently through observations, experiences and by trial and error.

Domestication and farming of medicinal and aromatic plants (MAPs) do not have a long history as compared to cereals, pulses, and other food crops. People depended upon wild resources for medicinal and aromatic plants due to obvious reasons of easy availability and low consumption. Shrinkage of natural habitats for MAPs and increase in the demand of medicinal and aromatic substances have led people to cultivate them for industrial purposes. In this regard Nepal is just a beginner. It is therefore timely to look into MAPs from horticultural perspective.

Medicinal plants possess useful chemical substances to relieve ailments of human beings as well as animals. A considerable number of definitions have been proposed for the term 'medicinal plant'. According to the WHO, "a medicinal plant is any plant which, in one or more of its organs, contains substances that can be used for therapeutic purposes, or which are precursors for chemo-pharmaceutical semi synthesis".

In spite of tremendous developments in the field of allopathy during the 20th century, herbs still remain one of the major sources of drugs in modern as well as traditional systems of medicine throughout the world. Synthetics and antibiotics show miraculous and often instantaneous results, so these have attained greater prominence in modern medicine but it is also a fact that these synthetics and antibiotics may prove harmful in the long run. That is why plant based drugs are popular these days. This situation has created a big demand of herbal medicines. So medicinal plants have age old tradition of diverse uses, which can be summarized as below:

- Household remedies
- Traditional medicines
- Modern drugs
- Health foods (herbal tea, herbal drink)
- Products for personal hygiene (tooth powder and paste, soaps, herbal aromas, herbal pillows etc)
- Cosmetics (shampoos, skin care, body care etc.)

Aromatic oils are compounds with odoriferous nature obtained from leaves, flowers, fruits, seeds, roots, rhizomes. These are also called as essential oil. The term "essential" refers to the presence of an essence or odor and the term "oil" is used because when these compounds are placed on a transparent paper, they leave behind an oily spot. Important uses of these essential oils are put as ingredients in the manufacture of soaps, cosmetics, perfumes, medicines, pharmaceuticals, plastic goods, textiles, leather, confectionary, perfumed tobacco, paan masala, aerated water, syrups, disinfectants, insecticides, fungicides, baby foods, biscuits, paper writing pads, cards etc. Plants, which possess aromatic or essential oil are termed as Aromatic plants.

Aromatherapy is getting popular as a type of alternate medicine in which healing affects are ascribed to aromatic compounds. Odors influence our sensory functions creating psycho-physiological reactions.

ASPECTS OF MEDICINAL AND AROMATIC PLANTS (MAPS)

There are different aspects of MAPs with their use patterns. These can be summarized as household medicines, traditional medicines, ethno-medicines and modern medicines. Household medicines just plainly cover a mother's household knowledge of curing children's ailments such as cough and cold, where as medicines practiced and transferred orally from generation to generation are traditional medicines. WHO defines traditional medicine as the sum of total knowledge, skills, and practices based on the theories, beliefs, and experiences indigenous to different cultures, whether explicable or not, used in the maintenance of health as well as in the prevention, diagnosis, improvement or treatment of physical and mental illness". According to World Health Organization (WHO) 80 % of the people in the developing countries of the world rely on traditional medicines and 85 % of the traditional medicines involve the use of plant materials. WHO has compiled a list of 20, 000 medicinal plants used in different parts of the globe (Gupta and Chadha, 1995), among these over one hundred plants are reported to have consistently large demand and are traded as major drug materials in the world.

In the same way ethno-medicine is the traditional medicine practiced by different ethnic groups especially indigenous groups.

Advances in the field of pharmacology led to the formulation of the synthetic drugs based on natural products in the middle of the 19th century. In 1839, for example, salicylic acid was identified as the active ingredient in a number of plants known for their pain-relieving qualities; salicylic acid was synthesized in 1853, eventually leading to the development of aspirin.

MAPS IN NEPALESE PERSPECTIVES

Wealth of MAPs

MAP documentation started since the period of Mandev, when the oldest book called Sushruta Nighantu was written on palm leaves in Devnagari script and Sanskrit verses where 278 MAP were recorded (Malla and Shakya, 1984). It was supposed to be a work of 5th century.

BIR NIGHANTU, a hand written herbal encyclopedia is the work compiled by Pandit Ghana Nath Devkota under the instruction of Chandra Samsher J. B. Rana and Bir Samsher J. B. Rana, the then Prime Ministers of Nepal at the end of 19th and beginning of 20th centuries. This Nighantu (hand written) describes medicinal uses of 750 plants with coloured paints. It is assumed to be the first literature in medicinal plants of Nepal. This work was not published unless the author's son Kosh Nath Devkota completed a concise form named Nepal Nighantu. It was published by Royal Nepal Academy in 1968.

Malla and Shakya (1984) enumerated 690 medicinal plants including 510 wild, 120 cultivated and 60 exotic species. Department of Plant Resources updating Bulletin no. 3 (1970) published in 1970 and Bulletin no. 10 (1997) has described 701 medicinal plants in Bulletin No. 28 (2007) including 177 cultivated, naturalized and exotic plants.

ESON (Ethno-botanical Society of Nepal) has prepared Medicinal and Aromatic Plants Database of Nepal (MAPDON), which includes 1624 plant species. This database also includes some exotic species.

Baral and Kurmi has described 1792 medicinal plants in Compendium of Medicinal Plants of Nepal (2006). This also includes many cultivated, naturalized and exotic species.

Regarding the commercial use, Subedi (2006) has recorded that 161 non-timber forest products (NTFP) species collected for commercial purposes, out of which over 50% are used primarily for medicinal purpose and about 7% used for essential oil.

RESEARCH AND DEVELOPMENT OF MAPS IN NEPAL

a. Mainstreaming with modern science and technology

MAPs were being treated and traded as "Jaributi" meaning crude herbs with healing properties. Government of Nepal initiated a separate section "Banaspati Phant" meaning plant section within the Ministry of Forest. It was upgraded as Banaspati Goswara and ultimately as Banaspati Bibhag during the year 1960 A. D. (2016 B. S.). It was a full fledged department called as the Dept. of Medicinal Plants (DMP).

The challenges to determine scientific identity of herbs, to ascertain their occurrence and distribution (phyto-geography), to identify their chemical constituents and active principles (phyto-chemistry and pharmacognosy), to record their local uses (ethno-botany, ethno-pharmacology, and to bring them under domestication were being addressed through DMP. The Department attempted to farm globally well known species of MAPs such as Belladona, Pyrethrum, Digitalis and also Kuth (Saussurea cosrus). However, domestication of indigenous herbs were not being considered until lately.

The Department was geared to provide scientific services to herbs collecting peasants, and herders, herb dealers, herb processors, herbal drug industries and so on. Horticultural aspects of herbs development should now be viewed as a promising opportunity on the face of declining wild resources and expanding global markets.

Department of Plant Resources (DPR) under the Ministry of Forests and Soil Conservation, Govt. of Nepal is the leading Govt. organization involved in the research and development of MAPs in Nepal from its establishment. It is a multidisciplinary organization with botanists, chemists and pharmacists focused on research and development of plant resources in Nepal.

DPR was established in 1953 (2009 B.S.) as Banaspati Goswara- led by the Senior Botanist Prayag Raj Pandey with the objectives of trade, farming, survey and collection and phyto-chemical studies on plant resources of Nepal.

- The Banaspati Goswara was upgraded to Department of Medicinal Plants (DMP) in 1960 (2016 B. S.).
- Master plan was developed for the development and utilization of herbs and drugs.
- Trade centers as Jaributi Bikri Kendra were established in Nepalganj, Koilabas, Butwal, and Tarahara.
- Outreach research stations were established as herbal farms in Shivapuri and Manichur, where research on cultivation of Belladona, Digitalis, Pyrethrum etc were started.
- Drug Research Laboratory under DMP was established in 1961 (2017 B.S.).

- Royal Botanical Garden, Godawari under DMP was established in 1963 (2019 B.S.)
- Botanical Survey and Herbarium under DMP was established in 1965 (2021 B.S.).
- Herbal research farms were extended in Daman, Tistung, Hetauda, Tarahara with technical assistance of Mr. P. S. Jamwal from Indian Govt. and started cultivation of Pyrethrum and Saffron in Manichur, Tistung, Daman and Rauvolfia in Tarahara, Hetauda.
- Trade centers were dissolved and converted into Botanical Survey Offices in Nepalganj and Koilabas.
- Later as Govt. policy of not involving in commercial production, Royal Drug Research Laboratory was separated and established Royal Drug Ltd. for commercial drug production as per company rules and mandates.
- Herbs Production and Processing Company Limited (HPPCL) was established for essential oil production and marketing
- At present Department of Plant Resources (former Department of Medicinal Plants) is working in exploring plants, development of agro-technology, phyto-chemical analysis, and certification of MAPs.
- Department of Forests has responsibility on the management of MAPs as Non Timber Forest Products (NTFPs).
- Nepal Agriculture Research Council (NARC) has developed agro-technology of Chiraita (Swertia chirayita) after a long research in NARC, ARS Pakhribas, Dhankuta, Nepal.
- The Govt. introduced Herbs and NTFP Development Policy in 2004 to conserve 'herbs' and NTFPs to contribute to the national economy. This policy calls for encouraging the commercial cultivation of valuable herbs and NTFPs; adding value to herbs and NTFPs through processing; improving access to capital in the trade; and developing necessary infrastructure and building technical knowledge and skills.

b. Reviving traditional medicine and strengthening Ayurvedic medicine

Ayurveda, meaning the science of life, is claimed to be the oldest of all medical systems of the world. It is said to have developed during Vedic period (ca 1500 – 900 BC).

Nepal Government's Ministry of Health and Populaton has a full fledged Department of Ayurveda, which provide medical services through hospitals like the central Ayurvedic Naradevi Hospital, Dang Ayurvedic Hospital, zonal dispensaries, and district health centers. The system is supported by Singh Durbar Vidyakhana as a production unit of Ayurvedic medicines.

Recent revival of Ayurved and other traditional systems like Sowa Rigpa (Tibetan Medicine) has opened up prospects of herbal farming for home remedy as well as marketable industrial products.

An illustratrious example of traditional medicine is revival is to be attributed to Yarsagumbu (half plant and half insect). The Himalayan caterpillar-fungus identified as Cordyceps sinensis. Currently it fetches over two million Nepalese Rupees per kilogram. Thousands of villagers desert their villages to go to alpine pastures above 3500 m to collect Yarsagumbu. Their two months toil brings income to meet the expenses for the rest of the year. Yarsagumbu collection is almost an annual festival in north-west Nepal (Mugu, Dolpa, Bajhang, and Darchula districts). The caterpillar fungus is the most celebrated medicinal commodity) used as an aphrodisiac health food in China, Japan, Korea, Hong kong etc.

It has been realized that this bio-resources has drastically declined in the wild and the need to bring it into cultivation is very obvious. Caterpillar farming for silk production is an age old practice. Yarsagumbu is a fungus growing upon the caterpillar of certain high altitude moth (Hepialus spp.), the identity of which is still incomplete (Devkota,S., 2008)

c. Research and development

Research and development on MAPs was initiated by DMP during 1960s. The T. U. Central

Department of Botany as well as Chemistry and thr Research center for Applied Science and Technology (RECAST) made significant contribution on botany, ecology and phyto-chemistry on Nepalese MAPs. Besides the Kathmandu University, Nepal Academy of Science and Technology (NAST) have undertaken applied researches to promote MAPs. The International Center for Integrated Mountain Development (ICIMOD) also promotes studies and researches on MAPs to support mountain development. Other relevant NGOs are Asia Network for Sustainable Agriculture and Bio-resources (ANSAB), Ethno-botanical Society of Nepal (ESON), the world conservation union (IUCN), the World Wildlife Fund for Nature (WWF), Jadibuti Association of Nepal (JABAN), Nepal Herbs and Herbal Products Association (NEHPA) and the like.

At present many Forest Users Groups (FUGs) under the Federation of Community Forest Users, Nepal (FECOFUN)are managing NTFPs of the community forests. FECOFUN is a formal network of Community Forest User Groups (FUGs) from all over Nepal from its inception in July 1995.

Since the mid 1990s, knowledge on biological, social and economic dimensions of MAP resources and enterprises, and the organization of the communities for different stages of MAP value chains has been generated through research, experimentation and continuous monitoring of impacts.Researches backed by experimentation from the organizations have improved understanding of policy provisions vs. implementation, contradictions in intended and actual impacts, and program implantation strategies for the government. As an example of knowledge generation, enterprise-oriented approaches to biodiversity conservation pioneered by ANSAB in Humla district of Nepal from 1995-99 generated information in terms of policy gaps and barriers, feasibility of biological monitoring, and significance of leadership, governance and marketing of NTFP-based enterprises (Subedi and Khanal 2014).

The organizations have also helped to develop a clear process and criteria for fixing and revising royalty rates and implementing the process, and simplifying trade procedures to support small business as well. Some of the policy reforms include the lifting of ban on some tradable NTFPs, rationalization of the royalty rates of over 50 products, prioritization of 30 NTFPs by HNCC for conservation and utilization, and formulation of NTFP Inventory Guideline 2012 (Subedi and Khanal 2014).

Since last fifteen years, there are some very good examples of successful local community systems of governing forest management and enterprise operation. For example, with ANSAB's facilitation, the communities have initiated systems of NTFP including MAP focused sustainable forestry and are generating biological and socio-economic information required for the management decisions, as reflected in their operation plans(Subedi and Khanal 2014).

TRADE OF MAPS

MAPs address not only the need for access to medicine as a component of health services but also create opportunity of income to collectors and farmers. Trade of medicinal and aromatic plants also creates employment and foreign exchange for developing countries as a significant contribution to the national economy.

The potential of MAPs was recognized by the Government of Nepal in the 'Nepal Trade Integration Strategy' (MoCS, 2010), which identified medicinal herbs and essential oils as having a medium export potential and a high potential for positive socioeconomic impact.

There is a long tradition of trade of MAPs from Nepal to India. It is assumed that 80 % of the collected volume goes to India, 10 % to foreign countries other than India and remaining 10 % is used in national herbal preparations.

Nepal's share in the world market for medicinal herbs is around 0.2 percent (MoCS 2010), and there has been corresponding increase in business volume and value in the country. Although there are variations in estimate of quantity and value of trade, the trend is very clear. The volume of trade for most of the commercial NTFPs including MAPs is increasing and the value is increasing significantly. For example, the government records show that more than 13,000 tons of NTFPs were traded in 2010 (DoF 2011), which was 3,350 tons in 1990 (DoF records). In 2012, the traded volume was about 11,680 tons, which also include large cardamom and essential oils (DoF 2013). Several studies show that the government records include only a portion of NTFPs traded, as informal transactions are common and the record keeping system is poor. Furthermore, these studies confirm the increasing trend of business. For example, the annual harvesting and trading of NTFPs was 10,000 to 15,000 tons with an export value of US $8.6 million in early 1990s (Edwards 1996) and 20,000 tons worth of US $18-20 million in late 1990s (Kanel 1999). Some other estimates show that NTFP trade involved an annual transaction of US $26 million in 1995 (Subedi 1997) and US $ 35.7 million in 2002 (Subedi 2006).

The increasing trend of annual value of trade is also demonstrated by the NTFP export value during the past two decades. TheNTFP export from Nepal is increased to NRs 515.4 million (about US $5.9 million) in 2012from NRs 23 million in 1992, which comes to be more than 2100%. Thecontribution of NTFPs to the total export from Nepal has also increased from less than 3% in 2003 to above 9% in 2012.

The industry has the potential to grow further, as there is a scope of expanding cultivation and processing of some marketable NTFPs in Nepal. Some prominent examples of successful cultivation in various altitudinal zones during this period include atis, chiraito, satuwa, sugandhawal, alainchi, timur, ritha, rudraksha, tejpat, chamomile, citronella, lemongrass and mentha (Subedi et al. 2014).

Raw products

Trade of MAPs in Nepal is on practice from the very early asJaributi. Mostly raw materials are exported.Thus the production of MAPs is the total quantity collected as wild and exported, purchased and used by the herbal companies inside the country. The tentative production data is the quantity licensed by all 75 District Forest Offices (DFOs) for export as raw or semi-processed. The data of the DFOs compiled by the Department of Forest (DoF) is given on the Annex-I.

Processed products

Essential oils are processed in some scale from raw materials of MAPs such as Jatamansi (Nardostachy sgrandiflora), Sugandha Kokila (Cinnamomum glaucescens), Sugandhawal (Valeriana jatamansi), but the products are banned for raw material export. Wintergreen oil, Juniper oil and Anthopogon oil are produced from other natural sources, where as

Tagetes, Citronella, Lemongrass, Palmarosa, Chamomile, Basil, Mentha are cultivated species for producing essential oil commercially.

Nepal exports about 55 tons of essential oil, positioning the country 72 in the list of exporters' category. Similarly, Nepal exports about 29 tons of essential oils to India only (Gurung, 2009).

Current trend:

The export of MAPs has now been changing its trend. MAPs are exported to China in high prices. Especially Yarsagumba, Chiraito and Satuwa are in high demand in China. This has hiked the price of these MAPs.

The recent trend of export presented in a recent study (Subedi et al.2014) is given below:

Medicinal herbs: The Nepal's export value of medicinal herbs in fiscal year 2012/013 was about NRs 1.2 billion. The export trend over the past decades shows that India is an established market for low value high volume products, whereas overseas countries buy the high value low volume products. More than 90% of the crude herbs are exported to India, with the remaining sent to other countries, such as the United States, Europe, Middle East and China. The supply trend, during the past few years, shows that the export of some high value crude herbs to China is increasing through both legal and illegal channels. For example, the export of some NTFPs including chiraito, ritha, satuwa, and rudrakshya to China has been initiated recently.

Essential oils: Since the past few years the production and export of essential oils has been increasing. Nepal produces about 70 tons of 16 different essential oils annually, out of which 64.2 tons was exported in 2012/13, which was 37.4 tons in 2011/12. The export value of essential oils in fiscal year 2012/013 was NRs 87.03 million, which is 13.3% higher than that in 2011/12. These essential oils are mainly exported to the EU (71%), India (11%) and USA (10%). Besides, Singapore and Australia are the most potential and attractive markets for essential oils. Available data shows that Nepal is in the 64th position for exporting essential oils at global level (Sharma and Shrestha 2011).

CULTIVATION OF MAPS

Nepal has a great potential for producing MAPs as horticultural crops as has already been evident with the cultivation of aromatic plants like menthe, lemongrass, citronella, palmarosa and the like. Agro-foresty of big cardamom has proved very promising along east Nepal hills. Attempts made for domestication and cultivation of chiretta (Swertia chirayita) have proved fruitful during last 10 – 15 years (Barakoti, 2004). Promising results of cultivation are also evident in the case of seabuckthorn (Hippophae salicifolia), taxus (Taxus wallichiana), soap-nut tree (Sapindus mukorossi), timur (Zanthoxylum armatum) and cinnamon (Cinnamomum tamala). Ginger and turmeric cultivation has an age-old tradition in Nepal.

The Master Plan for Horticulture Development (HMG/ADB, 1991) emphasizes on the agro-ecological approach to horticulture. MAPs cultivation without agro-ecological consideration may prove futile because MAP cropping is not aimed for primary metabolites (carbohydrates, proteins etc.) but for secondary metabolites (phenols, alkaloids etc.) synthesized by plants in order to cope with harsh climatic conditions, destructive pathogens as well as animal or birds invasion. MAPs therefore require inputs of ecological stresses in the process of farming/cultivation. As well nourished Ginseng farm may produce vegetable ginseng (carrot ginseng) while potent ginseng may require near-wild ecological habitat subjected to ecological stresses of nature. Three key aspects to be considered for horticultural development as regards to MAPs are (i) genology (ii) phenology and (iii) ecology of the crop.

Integration of medicinal plants with farm crop cultivation in eastern Nepal has been proved to be profitable to farmers (Pandit et al, 2008). However, existing rules and regulations on marketing and export do not favor domestication and cropping of native species occurring in the wild. Govt. rules and regulation are based upon wild resources of plants being collected from Govt. land (forest). Pandit et al, 2008 consider the lack of favorable institutional environment and has been the major factor constraining the MAP species integration into farmland.

MAPs are marketed on the basis of chemical constituents they contain. Therefore phyto-chemical determination and monitoring of constituents should be an integral part of cropping system.

- The research and development on cultivation of MAPs was started since 1960 after the establishment of DPR starting with Belladona, Digitalis and Pyrethrum. Later in the consequence of its work plan of the Department, research to develop agro-technology of MAPs (including indigenous and exotic) were continued and at present agro-technology of following MAPs have been developed by DPR.

S. No.	Botanical name	Common name	Nepali name
1	Asparagus racemosus Willd.	Wild asparagus	Satawari
2	Atropa belladonna L.	Belladona	Belladona
3	Catharanthus roseus (L.) G. Don	Periwinkle	Sadabahar
4	Chrysanthemum cinerariaefoliumVis.	Pyrethrum	Pyrethrum
5	Cinnamomum tamala (Buch.–Ham.) Nees and Eberm	Cinnamon	Tejpat, Nepali dalchini
6	Crocus sativus L.	Saffron	Keshar
7	Cympbopogonflexuosus Nees	Lemon grass	Lemon grass
8	Cymbopogon martini Stapf.	Palmarosa	Palmarosa
9	Cymbopogonwinterianus Jowitt	Citronella	Citronella
10	Matricaria chamomilla L.	Chamomile	Chamomile
11	Mentha arvensis L.	Japanese Mint	Pudina
12	Piper longum L.	Long pepper	Pipala
13	Rauvolfia serpentiana (L.) Benth. ex Kurz	Serpentine	Sarpagandha
14	Swertia chirayita (Roxb ex Fleming) Karstn.	Chiretta	Chiraita
15	Tagetes minuta L.	Tagetes	Jangalisayapatri
16	Valeriana jatamansi Jones	Valeriana	Sugandhawal
17	Zanthoxylum armatum DC.	Toothache tree	Timur

- Nepal Agriculture and Research Council (NARC) was involved to develop cultivation technology of Swertia chirayita in Agriculture Research Station (ARS),Pakhribas, Dhankuta from its germination to farming level in 1998.
- A new chapter in the history of MAPs cultivation and herbal extracts and essential commenced with the establishment of

Herbs Production and Processing Company Limited (HPPCL) in 1981. HPPCL has its production farms and processing units for six essential oil species. Commercial production of different aromatic oil species (Mentha, Citronella, Lemon grass, Palmarosa, Chamomile, French basil) is in continuation by HPPCL on its farms with the participation of farmers.

- Dabur Nepal also is involved in production of different herbs such as Akarkara and Kuth. Dabur with its Nursery at Banepa has been producing and distributing seedlings/ saplings of more than a dozen of MAP in Nepal.
- Other companies involved in cultivation and promotion of MAPs are Natural Product, Chaudhary Biosis, Shambhala Herbal, and cooperatives. Some government agencies (DPR, NARC, NAST, other), I/NGOs, and private companies have been involved in RandD activities. Palm Agrotech and Bio-Energy Nepal (P) Ltd. has initiated commercial cultivation of Stevia and Aloe vera on contract basis with farmers since 2010. As a result, cultivated area, and production have been increased to some extent. The production of indigenous medicinal plants is not done however Cinnamon, Swertia and Zanthoxylum etc. are mainly grown in the community forests.
- 30 MAP species have been prioritized for research and agro-technology development by DPR in 2063 B. S.

In a recent national level study conducted in 2014, ANSAB prioritized commercially important species and products including MAPs to increase private sector involvement in this lucrative business creating more employment and revenue for the country (Subedi et al. 2014). The study suggested following preliminary list of most promising MAPs from the plantations could be considered along with the continuous process and mechanism of identifying, assessing and prioritizing, which would be based on the emerging markets and technology of production and value addition.

Medicinal herbs – chiraito (Swertia chirayita) and satuwa (Paris polyphylla) in all mountain regions; atis (Aconitum heterophyllum) from the western mountain regions.

Essential oils – chamomile (Matricaria recutita), menthe (Mentha arvensis), lemongrass (Cymbopogonspp.), citronella (Cymbopogon spp.), palmarosa (Cymbopogon spp.) in the Terai through cultivation.

In this context it is mention worth that MAPs cultivation should be emphasized in harmony with their natural habitats based on agro-ecological zones. The suggested list has given in ANNEX – II.

Conservation:

Conservation of MAPs in situ has become a challenge for Nepal. Although there is positive impact of community forestry user groups in conserving MAPs in most areas.High value of MAP species such as Kutki, Jatamansi, Atis, Ban lasun, Satuwa are in threatened stage with continuous collection from nature as the cultivation practice not being being developed in the country. 60 high value species already categorized in various degree of threat by IUCN and CAMP should given priority for conservation.

National Parks are the protected areas for in-situ conservation of biodiversity including MAPs. From Terai to Himalayan areas there are 10 National Parks.

There are 12 botanical gardens under the Department of Plant Resources, where ex-situ conservation of CITES listed plants, Endangered plant species are being done including important MAPs.

Medicinal plant diversity is waiting for effective conservation strategy in the days to come. Hence, population and diversity of MAPs particularly the high value ones, are highly declining in their natural habitats leading to threatened, extinct categories.

CONCLUSION

Selection of plant species is an initial important step for the development of the MAPs. Economic feasibility is the major rationale for a decision to bring medicinal plant species into cultivation.

A large variation in climatic and soil conditions in Nepal sustain a variety of medicinal plant species, which may be cultivated according to their niche. For developing the medicinal plants sector, there is an urgent need to:

- Document indigenous as well as industrial uses of medicinal plants,
- Develop and improve the agro-technology for valuable medicinal plants,
- Conduct regular research and training on better harvesting and processing techniques,
- Setup a community-based management of medicinal plants farming and marketing,
- Analyze the market policies,
- Conserve the critical habitats of rare medicinal plant species.

Thirty priority species identified for agro-technology by DPR should be promoted and supported. Supportive government policies, assured markets, profitable price levels, access to simple and appropriate agro-techniques, and availability of trained manpower, Good Agriculture and Collection Practices (GACP) are some of the key factors for successful cultivation of medicinal plants.

REFERENCES

Barakoti, TP. (2004). Attempts made for Domestication, Conservation and Sustainable Development of Chiretta (Swertiachirayita).– A Compilation. NARC, ARS Pakhribas, Dhankuta, Nepal. 152 p.

Barakoti, TP and LD Pant (2008). Cultivation of Medicinal Plants in Nepal: An Overview of Opportunities and Constraints. Paper presented in the national workshop on medicinal and aromatic plants (MAPs), Dec 2011, Nepalganj, Nepal.

Baral, S. R. and Kurmi, P.P (2006). A Compendium of Medicinal Plants of Nepal, published by Mrs. Rachana Sharma, Kathmandu, Nepal

Batugal, Pons A, JayashreeKanniah, Lee Sok Young, and Jeffrey T Oliver (Eds) 2004.Medicinal Plants Research in Asia, Vol. 1: The Framework and Project Plans. International Plant Genetic Resources Institute-Regional Office for Asia, the Pacific and Oceania (IPGRI-APO), Serdang, Selangor DE, Malaysia.

Bhattarai, N., Tandon, V. and Ved, D. K. (2002). Highlights and outcomes of Conservation Assessment and Management Planning (CAMP) workshop, Pokhara, Nepal in Proceedings of the Regional workshop held at Pokhara, Nepal, 21 – 23 January, 2001.

Department of Forests (DoF) 2011.Hamro Ban, annual report of Fiscala year (2067/68), DoF, Babarmahal, Kathmandu, Nepal (in Nepali).

Department of Forests (DoF) 2012. Hamro Ban, annual report of Fiscala year (2068/69), DoF, Babarmahal, Kathmandu, Nepal (in Nepali).

Department of Forests (DoF) 2013. Hamro Ban, annual report of Fiscala year (2069/70), DoF, Babarmahal, Kathmandu, Nepal (in Nepali).

Department of Forests (DoF) 2014. Hamro Ban, annual report of Fiscala year (2070/71), DoF, Babarmahal, Kathmandu, Nepal (in Nepali).

Department of Forests (DoF) 2015. Hamro Ban, annual report of Fiscal year (2071/72), DoF, Babarmahal, Kathmandu, Nepal (in Nepali).

Department of Plant Resources (2063). Prioritized Medicinal plants in the economic development of Nepal: DPR, Thapathali, Kathmandu, Nepal

Department of Plant Resources (DPR) 2007. Medicinal Plants of Nepal (Revised): Bulletin No. 28 (2007). DPR, Thapathali, Kathmandu, Nepal

Department of Plant Resources (DPR) 2015. Policy of Herbs and Non-timber Forest Products Development-2061 and Plant Resources Research Procedure-2070. DPR, Thapathali, Kathmandu, Nepal.

Gewali, M. B. (2008). Aspects of Traditional Medicines in Nepal, Institute of Natural Medicine, University of Toyama, Japan

Gupta, R. and Chadha K. L. (1995): Medicinal and Aromatic Plants Research in India (pp. 1- 43 in Advance in Horticulture: Medicinal and Aromatic Plants, Vol. II, Malhotra Publishing House, NewDehli.

Gurung K. (2009). Essential Oils in Nepal: A Practical Guide to Essential Oils and Aromatherapy. Himalayan Bio Trade Pvt. Ltd, 2009.

Jha, P. K., Karmacharya, S. B., Chhetri, M. K, Thapa, C. B. and Shrestha B. B. edited (2008). Medicinal Plants in Nepal-An anthology of

contemporary research. Ecological Society (ECOS), Nepal.
Kanel, KR. (1999). Policy related issues in non-timber forest products business, In R.B. Rawal, B. Bhatta and A. Paudyal (Eds.), Non timber Forest Produces: Production, Collection and Trade of NTFPs in Mid Western Development Region of Nepal. Government of Nepal, USAID, BSP and New ERA.
Malla, S. B. and Shakya, P. R. (1984). Medicinal plants in Nepal. In: Majupuria, T.C. (ed.)Nepal Nature's Paradise.White Lotus Company Ltd., Bangkok, Thailand PP 261 – 297.
MoCS (2010). Nepal trade integration strategy 2010. Ministry of Commerce and Supplies, Government of Nepal.
Pandit, B. H., Mc Dougall, C., Kumar, C. and Mallik, M. K. in Jha et al edited
Purohit, S.S. and Vyas S.P.(2004). Marketing of medicinal and aromatic plants in Rajasthan, National Consultative Workshop on Medicinal and Aromatic Plants,held at GBPUAT, Pantnagar.
Sharma, P and Shrestha, N.(2011). Promoting Exports of Medicinal Plants and Aromatic Plants (MAPS) and Essential Oils form Nepal. South Asia Watch on Trade Economics and Environment. Report submitted to WTO/EIF Support Program, GIZ Kathmandu, Nepal.
Sharma, U. R., Malla, K. J. and Uprety, R. K. (2004).Conservatipn and management efforts of medicinal and aromatic plants in Nepal. BankoJanakari 14(2):3-11
Shrestha, K. K, Tiwari, N. N and Ghimire,S. K.(2001). MAPDON-Medicinal and Aromatic Plant Database of Nepal. In: Proceedings of Nepal-Japan Joint Symposium on Conservation and Utilization of Himalayan Medicinal Resources. Department of Plant Resources and SCDHMR, Japan. Pp. 53-74.
Shrestha T. B. and Joshi, R. M. (1996). Rare, Endemic and Endangered Plants of Nepal. WWF Nepal Program, Kathmandu, Nepal
Subedi, B. P.(2001). Marketing of Medicinal and Aromatic Plant Products of Nepal in Domestic and International Markets
Subedi, B.P. (1997).Utilization of non-timber forest products: issues and strategies for environmental conservation and economic

development. Workshop on The Utilization of NTFPs for Environmental Conservation and Economic Development in Nepal. Asia Network for Sustainable Agriculture and Bioresources. Kathmandu, Nepal.

Subedi, B.P. (2006). Linking Plant Based Enterprises and Local Communities to Biodiversity Conservation in Nepal Himalaya. Adroit Publishers. New Delhi, India.

Subedi, B.P., Ghimire, P.L., Koontz, A., Khanal, S.C., Katuwal, P., Sthapit, K.R. and Khadka Mishra, S. (2014). Private sector involvement and investment in Nepal's forestry: status, prospects and ways forward. Study report, Multi Stakeholder Forestry Programme, Service Support Unit, Babarmahal, Kathmandu, Nepal.

Subedi, B.P., and Khanal, S.C. (2014). NTFP-based enterprises: learning from Nepal for green and fair value-chain development. In: Sustainable forest management for multiple values: a paradigm shift. Forest Research Institute, Dehradun, India, 783–803.

UNEP, (2012). Green Economy Sectoral Study:BioTrade – Harnessing the potential for transitioning to a green economy – The Case of Medicinal and Aromatic Plants in Nepal.

Annex-I
Quantity of NTFPs (including MAPs) collected

Name	Botanical name	Quantity per Fiscal year in kg				
		2067/68	2068/69	2069/70	2070/71	2071/72
Atis jara	Delphinium himalayai	736.0	1,876.0	753.0	1,688.0	780.0
Amalbed	Rheum austral (petiole)	7,094.0	225.0	650.0	4,837.0	5,050.0
Amala	Phyllanthus emblica	124,520.0	18,400.0	67,038.0	27,050.0	12,000.0
Indreni seeds	Citrullus colosynthus/ Trichosanthes palmate	650.0	2,805.0	300.0	0.0	0.0
Kachur	Curcuma zedaoria	13,550.0	0.0	0.0	0.0	0.0
Kantakari	Solanum surratense	5.0	15.0	0.0	0.0	0.0
Kainyo phul	Pavetta tomentosa	0.0	0.0	0.0	600.0	0.0
Kakarsingi	Insect gall of Pistacia integrima	140.0	950.0	512.0	1,780.0	715.0
Kaulo ko bokra	Persea odoratissima	231,535.0	221,431.0	146,652.0	148,935.0	122,732.0
Kamraj	Helminthostachys zeylanica	150.0	0.0	0.0	0.0	0.0
Karachulthi	Rheum australe	800.0	1,360.0	1,700.0	3,759.0	0.0
Kaladanaa	Eulophia	7,924.0	8,207.0	8,394.0	13,866.0	25.0
Kutki	Neopicrorhiza scrophulariiflora	47,218.0	21,704.0	10,304.0	34,019.0	40,680.0
Kumkum pat	Didymocarpus pedicillatus	0.0	0.0	0.0	100.0	0.0
Kurilo	Asparagus racemosus	12,389.0	5,862.0	3,817.0	10,185.0	0.0
Guchchi chyau	Morchella spp.	1,022.3	137.3	319.2	1,298.0	675.5
Gurjo	Tinospora cordifolia	0.0	0.0	250.0	30,286.0	0.0
Gokul dhup	??	0.0	0.0	0.0	500.0	0.0
Ghod tapre	Centella asiatica	0.0	2,500.0	0.0	1,300.0	0.0
Chyau	Mushroom	5,572.0	4,017.0	1,037.0	10,674.5	4,409.0

Chabo	Piper chava	0.0	0.0	0.0	80.0	0.0
Chiuri	Aesandra butyracea	0.0	0.0	0.0	15.0	4,800.0
Chiraito	Swertia chirayita	55,422.0	84,858.0	38,097.0	211,602.0	3,312.0
Chutro	Berberis aristata	8,130.5	0.0	55,183.0	32,206.0	10,951.0
Jatamansi	Nardostachys grandiflora	68,263.0	13,596.0	36,631.0	25,509.0	77,252.0
Jangali jira	Carum carvi	30.0	0.0	0.0	0.0	0.0
Jhyau	Lichens	1,950.0	0.0	1,950.0	0.0	0.0
Timur	Zanthoxylum armatum	51,297.0	17,896.0	38,887.0	240,206.0	72,290.0
Tukiphul	Taraxacum officinale	100.0	3,600.0	0.0	300.0	0.0
Toklapatta	??	0.0	300.0	300.0	0.0	0.0
Thingure salla	Tsuga dumosa	8,000.0	0.0	0.0	0.0	0.0
Titepati	Artemisia indica	16,494.0	8,218.0	7,579.0	9,700.0	3,455.0
Tejbokra	Cinnamomum tamala (bark)	35,343.5	13,500.0	3,000.0	9,050.0	0.0
Tejpat	Cinnamomum tamala (leaves)	754,723.5	307,761.0	342,249.0	1,567,093.0	52,633.0
Tedupat	Diospyros sp.	42,187.0	33,200.0	7,015.0	39,500.0	0.0
Daruhaldi	Mahonia nepaulensis	0.0	1,300.0	0.0	50,810.0	0.0
Dalchini	Cinnamomum tamala	1,782.0	2,154.0	5,140.0	392,307.0	1,186.0
DShupi bokra	Juniperus (bark)	12,875.0	0.0	1,200.0	13,145.0	0.0
Dhupi pat	Juniperus (leaves)	27,223.0	20,370.0	1,200.0	76,695.0	11,950.0
Nagbeli powder	Lycopodium clavatum (powder)	200.0	1,150.0	1,538.0	0.0	0.0
Nagbeli lahara	Lycopodium clavatum (plant)	0.0	0.0	290.0	5,413.0	0.0
Nirmasi	Delphinium denudatum	314.0	54.0	694.5	2,107.0	0.0
Padamchal	Rheum australe (root)	4,385.0	16,533.0	11,495.0	28,517.0	62,834.0
Pakhanved	Bergenia ciliate (rhizome)	166,225.0	79,850.0	54,412.0	86,954.5	34,838.0
Pavan ko bokra	Persea odoratissima (bark)	20,502.0	57,750.0	7,086.0	22,740.0	0.0
Pipala	Piper longum	918.0	3,215.0	2,044.0	105.0	0.0
Pangra	Entada phaseoloides	0.0	0.0	0.0	400.0	0.0
Bajradanti jara	Potentilla fulgens	300.0	0.0	0.0	0.0	412.0

Bankarelo biyan	??	1.0	0.0	40.0	1,700.0	0.0
Ban lasun	Allium wallichii	2,157.0	3,163.0	1,638.5	54.0	1,038.0
Barro	Terminalia bellirica	0.0	0.0	0.0	700.0	0.0
Bisfej	Polypodium vulgare	4,117.0	230.0	0.0	1,415.0	0.0
Buki pul	Anaphalis sp.	30.0	6,495.0	3,510.0	0.0	0.0
Bojho	Acorus calamus	2,647.0	4,222.0	20,617.0	22,324.0	2,005.0
Bringaraj	Eclipta prostrata	0.0	9,008.0	0.0	2,500.0	120.0
Bhyakur	Dioscorea deltoides	30.0	0.0	0.0	0.0	0.0
Bhutksh	Selinum tenuifolium	544.0	0.0	0.0	0.0	0.0
Majitho	Rubia manjith	41,166.0	63,960.0	19,101.0	39,291.0	0.0
Masalapat	Eucalyptus sp.	0.0	300.0	0.0	80.0	0.0
Musali	Chlorophytum arundinaceum	28,426.0	4,040.0	11,354.0	0.0	0.0
Mom sahad	??	0.0	0.0	0.0	2,750.0	0.0
Yarsagumba	Cordyceps sinensis	888.7	511.0	280.3	1,294.9	350.4
Ramphal	??	0.0	0.0	1,250.0	1,507.0	0.0
Ritha	Sapindus mukorossi	569,759.5	284,124.0	148,125.0	384,651.0	46,464.0
Rudrakshya	Elaeocarpus shhaericus	341,675.0	261,880.0	0.0	938,490.0	0.0
Laghupatra	Podophyllum hexandrum	5.0	10.0	0.0	0.0	0.0
Lohaban	Pine resin	0.0	250.0	0.0	0.0	0.0
Banlasun	Allium wallichii	7,227.0	810.2	2,000.0	4,901.0	0.0
Brahmi	Centella asiatica	10.0	0.0	1,228.0	2,948.0	268.5
Bishjara	Aconitum sp.	2,180.0	900.0	12,201.0	5,570.0	50.0
Bishma jara	Aconitum spicatum	55.0	1,240.0	48.0	6,008.0	0.0
Satawari	Asparagus racemosus	5,447.5	500.0	2,600.0	2,784.0	0.0
Satuwa	Paris polyphylla	41,869.0	47,753.0	12,820.5	8,533.0	2,954.0
Salla ko simta	Pine cones	10,306.0	40,940.0	0.0	0.0	0.0
Sikakai	Acacia concinna	477.0	10.0	0.0	0.0	1,635.0
Siltimur	Litsea cubeba	2,550.0	500.0	596.0	2,200.0	0.0

Silajit	Rock exudation	1,050.0	200.0	3,190.0	5,042.0	4,730.0
Sisno jara	Urtica dioica	50.0	0.0	125.0	150.0	449.0
Sugandhawal	Valeriana jatamansi	16,156.0	6,143.0	18,224.0	30,147.0	9,382.0
Sunpati	Rhododendron anthopogon	3,915.0	3,020.0	0.0	33,480.0	0.0
Setakchini jara	Smilax spp.	18,600.0	11,765.0	12,366.0	21,286.0	0.0
Somalata	Ephedra gerardiana	2,500.0	300.0	275.0	113.0	1,000.0
Harro	Terminalia chebula	0.0	0.0	0.0	2,000.0	0.0
Miscellaneous	Others	49,657.0	870,705.5	46,023.0	187,387.8	1,099,653.9
Total		2,883,465.4	2,577,774.0	1,175,329.0	4,833,938.62	3,079,023.4

Source: Department of Forests (DoF), Babarmahal, Kathmandu, Nepal

ANNEX-II

Indigenous MAPs recommended for cultivation in ecological zones

Ecological zone	Altitude (m)	Estimated no. of MAPs	Recommended for cultivation
Alpine and Trans-Himalayan region	4000 – 5000	45	Dactylorhiza hatagirea, Hippophae tibetana, Picrorhiza scrophulariiflora, Rheum australe Swertia multicaulis Nardostachys grandiflora
Sub-alpine	3000 – 4000	114	Aconitum heterophyllum Dactylorhiza hatagirea, Ephedra gerardiana, Fritillaria cirrhosa Juniperus communis Juniperus recurva Nardostachys grandiflora Podophyllum hexandrum Rheum australe Rhododendron anthopogon
Temperate	2000 – 3000	225	Artemisia indica Cinnamomum tamala, Gaultheria fragrantissima Lilium nepalense Maharanga emodi Panax pseudo-ginseng Paris polyphylla Rubia manjith Swertia chirayita Taxus wallichiana Valeriana jatamansi Zanthoxylum armatum
Sub-tropical	1000 – 2000	340	Artemisia indica Cinnamomum glaucescens Cinnamomum tamala Phyllanthus emblica Valeriana jatamansi
Tropical		310	Acacia catechu Aegle marmelos Asparagus racemosus Phyllanthus emblica Piper longum Rauvolfia serpentina Tinospora cordifolia Terminalia bellirica Terminalia chebula

HORTICULTURE EDUCATION SYSTEMS IN NEPAL

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ABSTRACT

Nepal has varied agro-ecological regions where enumerable horticultural plant species are available. The commercialization of these crops requires appropriate production techniques based on the soil and climatic situation of Nepal and its various regions. Realizing these facts a need of manpower development in horticulture was felt by the government of Nepal. As a result, horticultural education (as a short-term training) was started in nurseries and gardens as early as 1937 A.D. However, the formal, one year course program was started in 1957 when the School of Agriculture was established. At present, many academic and non-academic institutions have come up for giving horticultural education and developing skilled manpower in this field. Institutions which give academic horticultural education are the Institute of Agriculture and Animal Science of Tribhuvan University (TU), the Faculty of Agriculture of Agriculture and Forestry University (AFU), the Himalayan College of Agricultural Sciences and Technology (HICAST) of Purbanchal University, Mahendra Ratna Multiple Campus, Illam/TU, Gokuleshwor Agriculture College/T, College of Live Science/TU, Prithu Technical College/TU, Nepal Polytechnique Institute, and the Council for Technical Education and Vocational Training (CTEVT) through its technical schools and affiliated colleges. Many of the non-academic institutions which run training courses in horticulture are ATD, FDD, VDD, NARC, NGOs, INGOs, Private Farms and Institutions, etc. This paper presents a brief information about these academic and non-academic institutions along with some recommendations for improving horticultural education.

INTRODUCTION

The agro-ecological conditions of Nepal are very much suitable for the successful cultivation of a large number of horticultural plant species from time immemorial either in a separate area or near a homestead gardens. For the systematic horticultural development in Nepal three aspects such as education, research, and development activities should be focused adequately in a planned manner. The Master Plan for

Horticulture Development in Nepal (MPHD, 1990) and Agriculture Perspective Plan (APP, 1995) have stressed a need for strengthening agricultural and horticultural education, which had been underway since 2014 B.S. (1957 A.D.).

Establishment of educational institutes for production of technical personnel in agricultural sector including horticulture was initiated from 2014 B.S (1957 A.D.) when the School of Agriculture was started at Jagadamba Bhawan to give agricultural trainings to develop low level manpower called Junior Technical Assistant (JTA) (Acharya, 2013; Shrestha, 1998). Later, in 2017 B.S, the school was converted into Jagadamba College of Agriculture and Research Institute in Shrimahal. Again, it was promoted to the Institute of Agriculture and Animal Science (IAAS) in 2029 B.S. under Tribhuvan University (TU). IAAS started to run I. Sc. Ag. Program at Shrimahal. IAAS was transferred from Lalitpur to Rampur, Chitwan in 2030 B.S. (1974 A.D). Since then, IAAS has offered several academic programs in agriculture and horticulture. This paper focuses academic and/or non-academic institutions involved in horticultural education systems in Nepal.

HORTICULTURAL EDUCATION INSTITUTIONS

There are many educational institutes which offer different courses of horticultural sciences to benefit for national economy. Broadly, these are categorized into a) Academic and b) Non-academic institutions. These are briefly described hereunder:

a. Academic Institutions:

Important educational institutions involved in giving agricultural education including horticultural education are dealt briefly hereunder:

Institute of Agriculture And Animal Science (IAAS): Development of Academic Institution for horticultural education in Nepal was started from as early as 1957 (2014 B.S.) when School of agriculture was established in Lalitpur for producing junior technical assistants (J.T.A.). This school was upgraded to College of Agriculture and Research Institute in 1968 (2025 B.S.) and was housed in Shrimahal, Pulchok. Separating the research responsibilities, this institution was renamed and established as Agriculture College under Ministry of Agriculture in 2027 B.S. which later converted into Institute of Agriculture and Animal Science under Tribhuvan University in 1972 (2029 B.S.). In 1974 (2030 B.S.), the Institute of Agriculture and Animal Science was moved from Shrimahal, Lalitpur to Rampur, Chitwan (Baral, 2012; Shrestha, 1998). Since then, various academic programs such as I.Sc. Ag., 3-years B.Sc. Ag., 1-year B.Sc.Ed, and 4-years B. Sc. Ag. with /without elective courses in horticulture were started. At present, the IAAS runs M. Sc. Ag. and Ph.D. degree programs in several disciplines including horticultural science. Two branch campuses of IAAS located at Sunderbazar, Lamjung and Paklihawa, Rupendehi also offer B. Sc. Ag. degree program with various horticultural courses.

Agriculture and Forestry University (AFU): AFU was established at Rampur, Chitwan, Nepal in June, 2010 (Baral, 2012). This is the first Agriculture and Forestry University in the country. AFU was founded by merging Agriculture Campus, Rampur and Forestry Campus, Hetauda; both these campuses were under Tribhuvan University, Nepal. AFU aims at producing highly skilled human resources required for agriculture and forestry sectors. This university inherits B.Sc. Ag., M.Sc. Ag. and Ph. D. programs in agricultural sciences of Rampur Campus and undergraduate program in forestry of Hetauda Campus. The educational programs are supported by quality research and developmental activities.

Himalayan College Of Agricultural Sciences And Technology (HICAST): The Himalayan college of agricultural sciences and technology is established in 2000 A.D. which started with offering B. Sc.(honours) Ag. The vision or motto of this college is "agricultural revolution through quality education". It is first private college in field of agriculture. This college is affiliated to Purbanchal university, Biratnagar.

HICAST was established with four major objectives: a) to produce academically and practically competent graduates in agriculture, veterinary and related technology, b) provide students with adequate opportunities and new vision to cope with the challenges of the new millennium, c) enhance linkages with national and international institutions, conduct collaborative and participatory research, workshop/training and seminars, and d) develop the college into a centre of academic excellence to promote sustainable livelihood and mutual respect among the people with diverse ethnic and socio-economic background. HICAST has strong curriculum in agricultural sciences with basic and elective course packages in horticulture. Currently, this academic institution runs several graduate and post-graduate programs such as M. Sc. in Dairy Technology, Meat Technology and Agri-Business Management.

Mahendra Ratna Multiple Campus, Illam/TU : Mahendra Ratna Multiple Campus (MRMC) Illam, the first autonomous campus of Tribhuvan University, by taking the advent of autonomy, has started four-year B. Sc. Program in Horticulture named "Bachelor's of Science in Horticulture and Floriculture Management (B. Sc. in HFM)". The curriculum was approved by the Academic Council of Tribhuvan University, Kirtipur in 2010 A.D. but the program was launched from 2012. The aim of this program was to prepare students for a wide variety of careers, entrepreneurship, exploratory enterprises or continual education in horticultural fields by developing both their technical and interpersonal skills so that its graduates would contribute by large to the development and promotion of the "hill economy" of Nepal and the adjoining regions. In addition, this program focuses on the assess, effectiveness and efficiency of management practices in horticulture and floriculture.

Table 1: Horticultural graduates/graduating students with degrees from B.Sc. Ag. Electives to PhD by academic institutions, 2014

Institutions	B.Sc. Electives	B.Sc. HFM	M.Sc. Hort	PhD	Total
AF/AFU1	----	----	(20)	(2)	22
IAAS/TU1	300+	----	100	4 + (2)	406
HICAST/ PU2	99 + (14)				113
MRMC/TU3	----	(88)	----	----	88
Total No.	413	88	120	8	629

Source: Personal communications with: 1Prof. Dr. D. R. Baral, Dean of Agriculture Faculty 2Bishnu Bhattarai, Coordinator of Agriculture program, and 3Bikash Khanal, Lecturer of MRMC Campus, Illam. Figures in parenthesis are graduating in near future.

Nepal Polytechnic Institute (NPI): Established in 1996 at Bharatpur, Chitwan, Nepal Polytechnic Institute (NPI) is the first public limited company of its kind registered under Nepal Company Act,2021 B.S. and Nepal Industrial Act, 2049 BS. The institute was established mainly to produce low to high level human resources in the areas of natural resource management, engineering, environment, management and medicine within a single umbrella so that coordinated efforts could be made to produce quality human resources trained in different disciplines. Offered degree programs in agriculture with horticultural courses are 4-year B. Sc (Hons.) Ag. and I.Sc. Ag. These programs are affiliated to TU .

Gokuleshwor Agriculture And Animal Science College (GAASC) : Gokuleshwor Agriculture and Animal Science College (GAASC) was established in 2013 A.D. and lies in Gokuleshwor VDC of Baitadi district in Far–Western Development Region of Nepal . It is located at nearly 300 meters above mean sea level in the beautiful tiny valley of Gokuleshwor on the bank of Chameliya river. It is the first college to get affiliation from Tribhuvan University to run B.Sc. (Agriculture) program. The college uses the premises of Shree Setigaun Higher Secondary School, Kakarpakha, Gokuleshwor, Baitadi at present, but it has started building its own infrastructures. The establishment of the college became only possible after a long and collaborative effort of local intellectuals, politicians and civil society. This institution follows the curricula of IAAS.

College of Live Sciences (CLS): This college is established at Tulsipur, Dang in 2014 aiming to run various academic degrees in the field of agriculture, veterinary, forestry, dental, tissue culture, and microbiology. Currently CLS runs B.Sc. degree in agriculture. This degree is affiliated with IAAS/TU and it is a 4-year program. The intake policy, course structures and examination activities are as defined by IAAS/TU. In this agriculture program, horticulture courses on fundamentals, fruits, vegetables, ornamentals, post-harvest of produces are dealt as per curriculum defined by IAAS/TU.

Prithu Technical College (PTC): Established at Lamahi of Dang district in 2014, the PTC also runs various academic courses in the field of four-year B.Sc. agriculture degree program at present. In this agriculture program, horticulture courses on fundamentals, fruits, vegetables, ornamentals, post-harvest of produces are dealt as per curriculum structures defined by IAAS/TU. This college follows all the intake procedures, course structures and examination activities as governed by the policy and regulations of IAAS/TU.

Council of Technical Education And Vocational Training (CTEVT): CTEVT through its constituted and other affiliated schools runs various technical courses including agriculture in different levels (diploma, proficiency certificate, or TSLC level). The duration for TSLC level programs varied from 15 months (for SLC graduates) to 29 months (for under SLC intakes). By the end of December, 2010 the total enrolment under CTEVT schools (managed as well as affiliated) was 8403 at diploma level and 10332 at TSLC level. Two programs of CTEVT in agriculture with various courses in horticulture are 1. Technical School Leaving Certificate in Agriculture (pre SLC program) and 2. Intermediate of Science in Agriculture (diploma in plant science).

Department of Education: Recently, the Government of Nepal through Department of Education in joint collaboration with CTEVT has started agricultural education program called "Technical and Vocational Education for Schools" which intends to give agricultural education in plant science. In this program horticulture stands as a major component. This education is given to the students of grade 9 and grade 10 at school levels in different districts.

b. Non-Academic Institutions:

In Nepal, horticultural education is also given by several non-academia of government, semi-government, non-government and international non-government organizations which offer courses of various nature for specific duration ranging from a few days to several weeks or months. Some of these institutions are briefly described:

Fruit Development Directorate (FDD): It was first established as Horticulture Section in 1955 A.D., which evolved as Fruit Development Section in 1966, Fruit Development Division in 1990 and as the Directorate in 2000 A.D. FDD is the central body responsible for the development of fruits, coffee, tea and ornamental crops in the country.

FDD, Kirtipur conducts need-based trainings to farmers in different emerging fruits like kiwi, pomegranate, olive, persimmon, citrus and other fruits; the trainings include in different activities from their cultivation practices to harvesting and postharvest management, which lasts for a duration of 7 to 10 days. Other centres of FDD located at different districts also conduct trainings in relevant issues in their command areas.

Agriculture Training Directorate (ATD): This organization is exclusively mandated for training based on specific curricula developed for training in agriculture, including horticulture for different levels from farmers to officer levels. To cite a few examples are: a) training for gazetted third class agricultural officers on "disease and pest management in mandarin orange", b) training for progressive farmers on " fruit nursery and garden management for subtropical and citrus fruit" and "general nursery management and postharvest technology", c) for progressive farmers "training for fruit nursery owner", "citrus fruit propagation and nursery management", "temperate fruit cultivation", "banana cultivation through improved technology" , "fruit orchard management and production technology for Terai" and "temperate fruit production technology and postharvest management", etc.

Table 2: Various trainings on agriculture, including horticultural crop commodities given by the Training Directorate and its Regional Offices in F.Y. 2068/69 B.S. (ATD, 2012)

Training level	Training Number	Total Trainees
Officer level	10	204
JT/JTA level	25	413
Progressive farmers	36	595
Total Number	71	1212

Nepal Agricultural Research Council: Nepal Agricultural Research Council (NARC) was established in 1991 as an autonomous organization under "Nepal Agricultural Research Council Act - 1991" to conduct agricultural research in the country to uplift the economic level of the people. To conduct research related to horticulture it has a separate Horticulture Research Division(HRD). It is one of the disciplinary division under National Agriculture Research Institute (NARI) of the NARC. Although NARC has exclusively mandated for research it also conducts some training to farmers, technicians, and others on various problem-solving issues of crops including annual and perennial horticultural crops but the curricula is not pre-scheduled by NARC. Almost all research stations having mandates in horticulture and located in different districts have training activities on horticultural aspects for various durations that focus on problem-solving issues in horticulture.

International Centre For Integrated Mountain Development (ICIMOD): ICIMOD is a regional intergovernmental learning and knowledge sharing centre and is based in Kathmandu, Nepal. Globalization and climate change have an increasing influence on the stability of fragile mountain ecosystems and the livelihoods of mountain people. ICIMOD aims to assist mountain people to understand these changes, adapt to them, and make the most use of new opportunities, while addressing upstream-downstream issues. ICIMOD strengthens networking among regional and global centres of excellence to develop an economically and environmentally sound mountain ecosystem to improve the living standards of mountain populations, yet sustaining vital ecosystem services for the present and for the future. This institute has established model farms for horticultural /perennial plant species including fruits, nuts, spices, and vine crops since 1993. As per the demand of farmers and other stakeholders ICIMOD also conducts some trainings on kiwi, lapsi, and others although such trainings do not fall within its objectives.

Private Organizations/Farms, NGOs and INGOs : In Nepal, there are several private organizations, NGOs and INGOs established in different parts of the country and they have their activities on horticultural crop production, promotion, development and research. These agencies also conduct short-term educational activities in horticulture, especially field-based training for developing skills on problem-focused issues of fruits, vegetables, ornamentals as well as plantation and spice crops. Usually, these educations are short durations ranging from less than one week to period not exceeding four weeks. Hellen Keller International, Education for Livelihood, Care Nepal, Plan International, LIBIRD, AAA, etc. are some examples to cite.

Other Institutions: There are many other institutions that are directly or indirectly involved in giving horticultural education through trainings and hands-on practice. Some examples are Horticulture Development Projects/Department of Agriculture, Central Department of Botany/T. U., Botanical Enterprises Pvt. Ltd. , Nepal Biotech Nursery, Microplants Nepal Pvt. Ltd., Green Research and Technology, Himalayan Botanical Research Centre, Department of Plant Resources, etc. These institutions work on micro-grafting, tissue culture and in-vitro propagation of horticultural plants such as apple, junar, banana, medicinal and aromatic crops, chrysanthemum, gerbera, gladiolus, African violet, lily, orchids, large cardamom, etc. Some or many of these institutions provide tissue culture training for entrepreneurs, farmers, students and researchers as and when needed.

CONCLUSION AND RECOMMENDATIONS

Although many institutions have emerged to contribute their roles in horticultural education systems in Nepal but specific organization which offers particular degree in horticulture is only a few to list. MRMC/TU of Illam has particular academic graduate program in horticulture. In his book entitled "Fruit Development in Nepal", Shrestha (1998) envisaged a need of Horticulture college and Agricultural University almost 2 decades back. Recently, an Agriculture (+ Forestry) University has been established only in 2010 A.D. (Baral, 2012). Under this university, a College of Horticulture should be established with strong academic programs inclusive of various courses and research objectives. For efficient and effective programs to launch quality education in horticulture it is necessary that such institutions be free from political turmoil as observed in academic institutions lately. Also, brain drain of horticultural graduates has been observed in recent years which must be minimized as far as possible by the government of Nepal giving due responsibilities and opportunities to the educated horticultural graduates within Nepal.

There is lack of national policy in horticultural education in Nepal. Within each of the academic institutions, strengthening of faculty members in various but new disciplines are urgently needed and such need was also suggested for IAAS by Dhakal (2001). Also, most of the institutions lack in sufficient infrastructures or they are in need of repairing; thus, timely attention of concerned authorities is a basic need for promoting horticultural education. Similarly, proper coordination, cooperation and collaboration among different institutions and stakeholders involved in teaching, research, and developmental activities are in great need.

Specific curriculum should be developed based on commercial value and entrepreneurships of each horticultural commodity, such as citrus, apple, mango, banana, coffee, cardamom, tomato, potato, etc. However, essential considerations should be given for proper regulation of educational institutions, development of appropriate curricula and their implementation, and proper monitoring mechanisms. Efficient management of Government-owned institutions, semi-governmental and non-governmental institutions should help promote horticultural education in future.

REFERENCES

Acharya, L. 2013 (2070 B.S.). Nepal ma Krisi Bikashko Aaitihasik Pristhabhumi ra Bikash ka Prayashharu (In Nepali), Agriculture Information and Communication Centre, Lalitpur, Nepal.

ATD. 2012. Annual Report of Agriculture Training: Program activities and Achievements of 2069 B.S. Agriculture Training Directorate, Hariharbhavan, Lalitpur, Nepal.

Baral, D.R. 2012. Agriculture and Forestry University: Organization, Status, and Future Priorities. Unpublished document

Dhakal, D.D. 2001. IAAS towards agricultural university : A strategic development plan. Tribhuvan University Special Bulletin 2001. Tribhuvan University, Kirtipur, Kathmandu.

IAAS. 2011. IAAS Bulletin, Institute of Agriculture and Animal Science , Rampur, Chitwan, Nepal

MPHD, 1990. Master Plan for Horticulture Development in Nepal. Pacific Management Resources Inc. USA in association with East Consult (P) Ltd. Nepal.

Sah, Saha Dev. 2015. College of live sciences, Tulsipur, Dang. Personal communications.

Shrestha, G.K. 1998. Fruit Development in Nepal. Technica Concern, Kathmandu, Nepal.

LOOKING HORTICULTURE FROM EXPORT-IMPORT PERSPECTIVE

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ABSTRACT

Trade of horticulture products in the world is growing every year because of the increasing demand to feed the growing population and the also change in the food habit of the people. Nepal being situated in between the two giant nations of the world China and India. It has ample opportunity to produce any horticulture products produced in the world in having the similar topography and climatic zones in the globe. It has made an ample opportunity in export trade of the horticulture products. However, still country not been able to harness this opportunity because of the low level of production and less ability in compliance to the emerging quality concerns of the neighbouring countries and world markets. It has been observed from the current growth pattern and the endeavours made by the government and the private sector in Nepal. There still needs to put more efforts in increase in production and trading capacity. The capacity in production at larger scale and enhance the capacity of the farming community and the agro enterprises in the country is still in low pace. It requires further efforts to enhance the capacity of the farming community to be involved in the commercial scale production of the horticulture products and at the same time attract more private sector investment in agriculture by revisiting the laws and regulations and attract Foreign Direct Investment in agro processing business is required to grab the opportunities in horticulture trade. There still lacks implementation of developed Agribusiness Promotion Policy and Agriculture Policy in Nepal to facilitate much needed growth of agriculture business in Nepal.

INTRODUCTION

Horticultural products include all products, raw or processed that arise from the horticultural industry (International Society for Horticulture Science). To simplify in the understanding of horticulture for the general purpose, we define the horticulture as growing and producing plant based produced except staple food for human and animal consumption.

More specifically to the prospects of its commercialization and income generation, we narrow down to the cultivation, production, processing and marketing of plant based products for human use. In this paper, we are more confined to the fruit and vegetable products produce, produced and traded in Nepal, which includes export and import too. The emerging questions of population growth and food supply have long been of central concern to economists. The World Food Economy seeks to examine the lessons of the past for wealthy nations, where agricultural output has steadily risen for decades, as well as for developing nations where the advances of the "Green Revolution" in the 1960s have introduced new problems in addition to solutions.

AREA AND PRODUCTION OF FRUITS AND VEGETABLES

Production of fruits and vegetables to meet the growing food demand during the twenty-first century as consumers and producers in every part of the world—rich and poor alike—feel the effects of expanded global commodity trade, food aid, and national legislation in response to globalization and its implications in the national context of Nepal. Area and production of horticultural crops in Nepal is presented in Table 1.

Table 1: Area and production of horticultural crops Area: '000 ha, Production: '000 mt

Commodity	2009/10		2010/11		2011/12		2012/13		2013/14	
	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod
Fruits Temperate	22.5	107.6	24.1	111.9	26.4	130.8	24.7	122.4	25.2	113.7
Citrus	33.9	259.2	35.6	263.7	37.6	240.8	37.0	216.2	39.0	224.4
Tropical	50.9	340.2	58.3	318.6	75.3	658.2	76.1	600.1	84.0	627.0
Fruit total	107.3	707.0	117.9	794.2	130.3	1,029.8	137.8	938.7	148.2	965.0
Vegetable	235.1	3,003.8	244.1	3,203.6	245.0	3,298.8	246.4	3,301.7	254.9	3,421.0

Source: Statistical agricultural information, 2013/14, MOAD.

The horticulture components continued to pose incremental trends toward areas and productivities. Provided condition for every Nepalese consuming 100 g and 300 g of Fruits and Vegetables daily, Nepal's main horticulture produce remains covered.

Cereal crops like rice export potential remained in historic event in Nepal. After realization of export prospective of horticultural produce for faster economic growth, Nepal initiated sectoral policy for the development of specific benefited crops. Cardamom, Zinger, Potato, Tea and Coffee are some of the qualified example contributing national economy.

Nepal country been entered into global market, Nepal has widened and diversified its agricultural produce so as to maximize benefits from international niches. Now, staple food crop production became substantial, some of the country's export potential crops do not qualify the global standard and remains uncompetitive. Also, the bilateral or multilateral agreements are not very supportive to Nepal enter into global marketing. In such circumstances, Nepal needs to assess and explore the additional efforts in term of increase production and productivity, product quality assurance and export potentiality.

OPPORTUNITIES AND CHALLENGES

Nepal still posses the ample opportunities in the horticultural products from production to Marketing. As being the neighbour of the two giant countries in Asia, India and China, this country enjoys ample unused market and demand and also faces challenges of low cost in production and trade of the products in the neighbouring countries. Because of Nepal is lagging behind technically and government support in agribusiness development, its opportunities have been descended from ensuing the prospect.

The emerging challenges are Non–Tariff Barriers specially the quality concerns at larger extent for Nepal has created more challenges in international marketing. Pertinent quality concerns and the requirement in general in the global food and consumer market influencing horticulture market are presented in Table 2.

HARNESSING THE OPPORTUNITIES

Efforts made from government of Nepal.

Nepal being an agro based economy country, the government has given high priority in the agriculture and agribusiness development for the economic upliftment of the people. From the initial planning process in 1955 AD (2013 BS) the first Five year plan. Agriculture has been given first priority and still has been duly considered in the priority program of the government. Some policy reforms were started since the formulation of Agriculture Policy 2061 B.S followed by the Agribusiness Promotion Policy 2063 B.S. Then Agriculture Perspective Plan a long term development plan for 15 years was implemented till the year 2014 AD and now we are in the threshold of another long term development plans strategies as "Agriculture Development Strategy (ADS).

In addition, government of Nepal has taken series of initiatives to promote trade by enabling business friendly environment to achieve overarching national goal of sustainable and inclusive economic growth, poverty reduction and improving the living standard of people. The country formulated Nepal Trade Integration Strategy (NTIS) was adopted in 2010 to provide directional measures for export promotion. NTIS 2010 charted out actions and intervention in cross-cutting areas and priority export potential sectors. It had identified 19 products which has greater potential of exports. Among them major exportable horticulture products including Tea, Cardamom, Ginger and Lentils were included.

Despite these efforts, anticipated results on trade performance could not be achieved over the past decade, resulting to widening trade deficit. Poor performance of Nepalese horticulture trade is mainly attributed to supply side constraints, low investment, and inadequate trade infrastructure and trade facilitation measures, among others. Hence, it is crucial for Nepal to adopt intervening policies and strategies to address the challenges related to value chain development of priority export potentials (goods and services), improve trade facilitation, and export promotion in existing and potential markets. Nepalese exports. However, Nepal's export related problems are largely domestic in nature.

MAJOR CHALLENGES IN HORTICULTURE BUSINESS DEVELOPMENT IN NEPAL

In the present context, five key issues have been experienced the major issues in the promotion of agriculture trade and enhancing competitiveness of agriculture sector:

- Supply side constraints, inadequate infrastructure for efficient production and transportation of goods; lack of human capital endowed with education and skills to process exportable; limited access to credit due to conventional/conservative banking practices that rely more on collateral than on the feasibility of business ventures; limited use of technology in the production processes.
- High transport and transit costs, being landlocked country and inadequate domestic transport network, the cost of transit and transport is high. The tariff faced by Nepalese agriculture products is about 5 times higher than the tariffs for non-agriculture products.
- Market access barriers, in addition to high tariffs in export markets, human, health, environment and technical standards and requirements for agricultural products have become more frequent and stringent in export markets.
- Low support measures, from the government in input supply and market access development and lack of private sector investment friendly regulatory frameworks.
- Unfavorable provisions in Nepal-India trade treaty and exchange regime. Nepal-India trade treaty which provides reciprocal duty free market access on selected agriculture and primary products has resulted in displacement of agricultural products in domestic market as evident from the increasing trend of the share of imports of food items in the food consumption.
- Lack of implementation of Government policies for promoting commercialization and attracting the private sector investment.

Additional challenge is also increasing because of the emergence of Non-Tariff Barriers in Trade: Nepal being an LDC avails low tariffs and SandDT preference in the international market, tariffs not being the major barrier to trade. However, China still need to provide LDC's privilege to Nepal.

Most of the export products including the priority products identified by this Strategy face NTBs related problems; Sanitary and Phyto-Sanitary (SPS) related barriers on agriculture and forest based products. The quality assurance mechanism is not sufficient to meet the standards required by the importing countries. This basically requires adoption of internationally recognized SPS and TBT parameters and development of appropriate quality infrastructure for testing and certifications. Efforts are being made for accreditation of some parameters for some agricultural and industrial products, but the Nepalese laboratories largely remain fall short in getting international accreditation for a large number of export products. As a result, it has caused difficulties to comply with international standards and regulations related to quality assurance and certification. Some of the relevant quality standards requirement in world market of horticulture and food trade is presented in Table-2 below.

Table 2: Prominent Standards in the horticulture industry

	Public		Private	
	Mandatory	Voluntary	Individual	Collective
National	• National legislation (pesticide use, labor regulations, sanitary inspections etc) • U.S. Department of Agriculture (USDA) standards	•Hazard Analysis Critical Control Point (HACCP) •USDA National organic program	• Nature's Choice (Tesco) • Field-to-Fork (M&S) • Terre et Saveur (Casino) • Conad Percorso Qualità (Italy) • Albert Heijn BV: AH Excellent (Netherlands)	•British Retail Consortium (UK) •Assured Foods Standards (UK)
Regional	• EU Regulations		• Filieres Qualite (Carrefour)	•EurepGap[11] •Dutch HACCP •Qualitat Sicherhiet (QS – Belgium, Holland, Austria) •International Food Standard (German, French, Italian)
International	• World Trade Organization SPS Agreement	•ISO 9000 •ISO 22000	• SQF 1000/2000/3000 (U.S.)	•GlobalGap •Global Food Safety Initiative •SA 8000 •International Federation of Organic Agriculture Movements (IFOAM) Standard

Sources: Gereffi & Lee, 2009; Henson & Humphrey, 2009; Jaffee & Masakure, 2005.

POTENTIAL MEAUSRES TO OVERCOME THE CHALLENGES

In order to allow Nepali export products to compete in international markets on the one hand while protecting the Nepali consumers from consuming unsafe food products, the following steps have to be taken:

Enact a modern Food Act, prescriptive rather than reactive, that creates an enabling environment conducive to the development of internal trade and export market of agricultural and agro-business products as well as ensures that all foodstuffs sold meet acceptable standards.

The new Food Act should include provisions on the following matters:

- The formation of an independent Food Authority that is affiliated to but not part of structure of ministry with authority to issue standards and enforce these, including food quality standards
- The stipulation that the DFTQS (or the Food Authority once established) is authorized to issue SPS standards for local and exported goods;
- The authority to issue SPS standards by a simplified procedure in case that the SPS standards are internationally accepted standards, such as those of the Codex Alimentarius.
- Formulate, adopt and implement FSQ standards that meet international SPS standards to avoid import restrictions by trading partners for SPS reasons. Set numerical goals for proclamation of new standards
- Adopt legislation on the accreditation of national laboratories for FSQ certification;
- Establish Nepali accreditation body
- Establish recognition of Nepali accreditation body

Institutional measure in the short term include: (i) Strengthen the capacity of the DFTQC under the MOAC, in terms of transforming it to become a pro-active rather than reactive body, with annual plans and targets for the proclamation of FSQ standards, enforcement of FSQ standards and public awareness; and (ii) Implement agreement with India on recognition of DFTQC as certified laboratory by India.

In the mid-term: (i) Form Food Agency under new Food Act with full authority to proclaim FSQ standards and enforcement thereof; and (ii) Establish Nepali accreditation body for laboratory certification.

In order to build surveillance and monitoring capacity for plant pests and diseases, survey-based data gathering and management will be strengthened and diagnostic and analytical services will be improved (through investments in facilities, equipment, supplies and human capacity). Necessary interventions will be targeted at raising the capacity of the Plant Protection Center (PPC) to better carry out pest and disease surveillance activities, including: (i) crop pest surveillance; (ii) diagnostics and taxonomic identification; (iii) post-entry quarantine (PEQ) for seed and other propagative plant materials; and, (iv) response to plant pest and disease outbreaks. There is a need to move from an ad hoc approach to the implementation of a sustained and planned program of surveillance on priority crops, with scheduled completion dates. More robust taxonomic identification of survey specimens will be promoted (with regional support, and access to external support for difficult specimens) to expedite the diagnostics component of the survey. PPC staff will be given on-the-job training. There will be upgrading of current laboratory and equipment.

FURTHER EFFORTS REQUIRED IN COMMERCIALIZATION OF AGRICULTURE AND PROMOTION OF HORTICULTURE BUSINESS

It has been experienced in the past trends and the new trade trends, we can recommend for some more efforts which are required for the larger scale operation of the business in commercialization and trade of horticulture products in Nepal. It can be outlined as below:

- Increase in scale of production : Improved productivity of land and labor is the need of the country to enhance agricultural development and promotion of horticulture business. Agricultural productivity requires the adoption of improved and appropriate technologies and know-how to increase efficiency and sustainability of agricultural production consistent with market demand. The measures to raise agricultural productivity include those related to: (i) effective agricultural extension and research; (ii) efficient use of agricultural inputs; (iii) efficient and sustainable use of natural resources (land, water, soils); and (iv) increased resilience to climate change and disasters.

- Promote participation of private sector, NGOs, and public sector in agricultural extension and adopt a pro-poor decentralized extension system approach: The approach requires considerable capacity building of service providers to enhance their capacity of responding to the demands and needs of users. iii. Major involvement of private sector, cooperatives, International NGOs, community based organizations (CBOs), individual resource persons, universities and training institutions into various forms of public-private partnership modalities (PPP).
- Establishment and capacity building of a network of village extension workers.
- Introduction of a coupons system that would empower farmers to buy the best available extension and advisory services that meet their demand.
- Promote use of innovative forms of Information and Communication Technology (ICT).

FURTHER EFFORTS REQUIRED FOR TRADE OF HORTICULTURE PRODUCTS IN EXPORT MARKET:

In view of improving the quality assurance of the Nepalese export products, the major areas of intervention would be as follows:

Efforts required from the Government of Nepal

- Improvements in the legislative and institutional framework for the enforcement of quality assurance which includes;
- Strengthening inspection, testing and certification infrastructural facilities along with human resources development;
- Accreditation of national testing and certifying laboratories (authorities).
- Harmonization of Food/Plant and Animal standards as per the international standard requirements.

- Lift restriction on imports of Nepalese agriculture and livestock products in India.
- Validity of Nepalese quality and standard testing certificates.
- Waiver on additional duties like CVD (Counter valuing Duties at par of Indian excise duty).
- Formation of Local Committee as stated in the Article XI of the Nepal India Trade Treaty to solve the local problems in clearance of goods at local customs points.
- Need to establish laboratory or facilitate speed up lab tests for food items including tea, coffee and others as per the Indian Food Safety and Standard Regulations 2011.

Capacity building and strengthening the government agncies this includes:

- DFTQC – develop pesticide residue testing mechanism and work on having its certificate accredited internationally, enhance capacity, promote private sector laboratories
- Enhance and strengthen the technical capacity of existing Plant Quarantine Offices of Kakarvitta, Biratnagar, Jaleshowre, Birgunj, Bhairahawa, Rupedia and Gaddachowki and other upcoming check posts
- Issue quality and phyto-sanitary certificates on thorough inspection to adhere with the quality standard of India and other importing countries.

Compliance issue and its potential remedies

- Nepalese Govt. Labs needs to be duly comply with international test parameters for issuing test certificate.
- Capacity building of Plant Quarantine program in PRA, PFA and Fumigation procedures.
- Frequent and regular meeting of High level authorities of both India and Nepal to discuss on the issues of SPS and quality concerns e.g PRA, PFA and other analysis requirement for export of Tea, coffee and food items, Cardamom. Ginger and other vegetable products from Nepal.

Enhance role of Private Sector in boosting production and trade

The role of private sector in promoting horticulture business is now more concentrated to trade and export. It needs to contribute more on following areas of development to strengthen the supply chain of the horticulture trade to bring the scale of operation at the larger area. Further efforts need to:

- Improved and expanded Supply Chain management(seed, fertilizer, output market and distribution)
- Investment in agribusiness at the larger scale operation including farming and processing business.
- Expand trading capacity including third country export/ import
- Develop and manage horticulture products market by establishing collection and marketing centres in the production pocket areas.
- Make available market information services for the producers and traders.

CONCLUSION

In conclusion their needs more efforts shall be made to increase in production of the horticulture products. It can be more specifically addressing the following current issues.

Increase productivity and value addition through commercialization and irrigation investments.

- Commercialization: This will require action along several fronts, including policy support, meeting quality standards, capacity building and market information for producers, applied research, and investment in the supply chain for high value commodities. For the export trade, strengthening institutions and systems for quality control and certification, and investing in laboratories, accreditation of the existing government labs with international laboratories, investment in testingstations, and human resources is given higher priority in the government programs.
- Irrigation and emphasis on farmer management: Irrigation infrastructure can be improved by: (a) promoting both surface and groundwater irrigation for commercial and industrial crops in the Terai, while encouraging high-value horticulture and cereal

production in the Mountains and Hills, promoting Micro Irrigation Technology (MIT) and plastic tunnel off season vegetable production (b) developing year-round irrigation in perennial flow areas and small storage facilities like cellar storage facilities in other areas (c) investing in mini- and micro-hydro facilities, to facilitate power generation and lift irrigation in the hills.In addition, government should encourage farmer management of irrigation infrastructure, and support matching-grants for demand-driven farm interventions.

Improve the functioning of factors of production and marketing.

To enhance the proper functioning of factor markets in Nepal, reviews should be done based on some cross-country experiences. Reviews of the land redistributive policies for achieving a more accessible legal system and minimize the land disputes and also for identifying the market and non-market mechanisms to improve access to land. Improvement in land administration systems, particularly land title records for providing greater security of ownership and reduce transactions costs, eliminating multi layer local taxation system are some of the areas to be improved. One potential solution would be to initiate Contract Farming System at the earliest. Facilitate marketing by establishing the marketing centres and collection centres in the accessible areas for the farmers' benefit and aggregate production to cater the growing demand of agriculture products.

Also there is a need to work on the rural finance for developing strategies to provide services to people in isolated areas, where the traditional Gramen model is unsuitable.

Reach out to the poor and increase investment in the basic infrastructure

Decentralized approach to empower communities and devolve decision-making power to the local level is needed for better service delivery. For this sake, use of the non-government / private sector agencies is an important vehicle to facilitate access to livelihood opportunities for the rural people and income generating activities involving them in commercial scale farming business. It could be a mix of local, public and private investments pattern in roads, communication and power which are critical to improve access to assets, integration with markets. The role of local government needs to be enhances in order to promote the agribusiness investment through the local development fund. This will provide opportunities to involve more local poor in the agribusiness, which ultimately contributes to the production and trade.

Insure the supply of fertilizers, seeds and agricultural equipment for all

Supply of chemical fertilizers needs to be kept open for the private sector to ensure the supply for meeting the current demand and subsidy should be given to the fertilizer and seed instead of present practice.

Bring in action the Agri Business Development Policy by revisiting the land act and other related acts and bringing the new "Agri Business Promotion Act" at the earliest possible.

Effective implementation of "Agri-Mechanization Policy" and its implementation is needed to ensure that the farmers get opportunity to mechanize farming practice and cope with the present labor shortage situation. Furthermore, reforms in the legal environment to promote larger scale agri- business requires to revisit and revise the existing laws and regulations to attract Foreign Direct Investment in Agro-processing business. Also promotion of farming business at larger scale by making incentive provisions in subsidizing the bank interest rates, income tax act, VAT and export incentives

REFERENCE

Agriculture Policy 2061. Government of Nepal , MOAD

Agribusiness Development Policy, 2063.

Agriculture Development Strategy, (ADS) 2014 A.D.

Agriculture Diary, 2072 BS. MOAD

IMPORTANCE OF VALUE ADDITION IN HORTICULTURE

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ABSTRACT

Nepal got possibilities of producing a range of horticultural commodities and, therefore, value addition and marketing of such commodities. However, value added horticultural products contribute major share of Nepalese agricultural commodity import market. The present scenario of horticultural commodity market is assessed and policy as well as technical recommendation to strengthen value added market has been proposed in this paper.

INTRODUCTION

Horticultural crops are the major sector of Nepalese agriculture and a wide variety of fruits and vegetables has been produced in Nepal with total annual production estimated at 965044 metric tons of fruits and 3421035 metric tons of tons of vegetables in 2013/14 (MoAD 2014). The horticulture sector has a fundamental role in farm revenue improvement, poverty mitigation, food security, and sustainable agriculture. This sector, however, suffers greatly from postharvest losses. Some estimates suggest that about 30–40% of fruit and vegetables are lost or dumped after leaving the farm gate. Huge postharvest losses result in diminished returns for producers. International markets discard fruits and vegetables containing illegal pesticides, with pesticide residues beyond permissible limits, and with inadequate labeling and packaging (FAO, 2006).

Value addition of horticulture produce is not recent act. It has been started by human being since ancient- time. The first idea of value addition was preserving food for lean period. Value addition is a process of increasing the economic value and consumer appeal of a commodity. It is a production/ marketing strategy driven by customer needs and preferences. Produce is changed from its original form to a more desirable form e.g. apple pie, jams, jellies and pickles etc. There is an abundant supply of produce in season, if the excess is not conserved it will decay and go to waste. Usually when supply outweighs demand and product fetches less money. The simplest form of value addition is undoubtedly drying vegetable. For e.g. making sandana and chana (dried radish slices). Anaerobic fermentation and drying of vegetable parts (gundruk or mountain soup) is another twist in value addition and marketing of such produce got increasing scope within Nepal and abroad. The value added product development in Nepal initiated with production of bottled pickle from different small cottage industries but there is lack of statistics on the volume of production and sale from such industries. The market oriented production value added products was started with establishment of Rijal Tashi Processing Industry in Itahari in 1981 (http://www.rijaltashi.com.np/). This industry is producing jam, sauce, squash, juice, vinegar, canned fruits and pickles from various fruit crops.

IMPORT AND EXPORT STATUS

Nepal's agricultural import and export trade comprises about 15.6% of total trade. Agricultural trade is dominated by export of lentils, tea, cardamom, fruit, ginger, and medicinal and aromatic plant products (MAPs), with import of fruit, cereals, vegetables, beans (mostly peas), dairy products, meat animal, and raw materials for processing (oilseeds) and manufacturing (fibers for carpets, garments and textiles). There is good potential for import replacement in vegetables, fruit, beverages, dairy and meat(ADS Report 2015). The import and export figure of value added horticultural product of Nepal shows steady increase in both export and import (Table 1). The import is always higher than export of commodities. The dried fruit and nut is the mostly imported product while processed tea, coffee and spices got highest share in export of such commodities in year 2014 (Fig 1).

Table 1. Import and export of value added horticulture product.

Year	Export (NRS in millions)	Import (NRS in millions)
2009	3348.9	7500.8
2011	5485.7	6338.1
2012	6177.1	7264.0
2013	11286.8	8396.7
2014	15605.8	86872.1

(Source: Statistical year books from MOAD, www.moad.gov.np/publication)

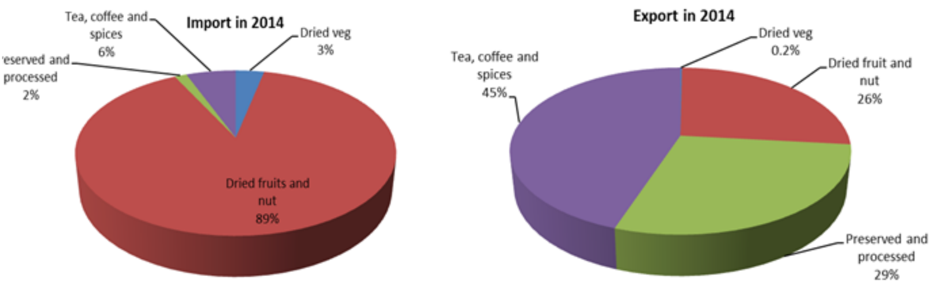

Fig 1. Import and export of value added horticultural products (Source: MoAD statistical year book 2014)

SCOPE AND LIMITATION OF PRODUCTS

In view of limited access to transportation network in the hilly areas, the movement of horticultural produces like perishable fruits and vegetables is still a challenging task. Nepal possesses a great diversity of natural environment where a variety of fruits and vegetables such as apple, peach, plum, banana, mango, and walnuts can be produced. This situation makes the abundant supply of seasonal gluts of horticultural produces in the country and some quantities get wasted due to unavailability of proper postharvest handling and value added processing.

The processing technology of horticultural products range from primary and modest scale used in cottage industries to the modern enterprises that manufacture tetra pack fruit products. There are several fruit and vegetable processing industries of cottage and small scale which manufacture jams, jellies, squash, candies, fruit juices, dried fruit/ vegetable products etc. most of the processing equipment like bottle sealers, pulpers, juice extractor, are imported from India and China Besides some modern equipment such as Tetra pack is from Sweden. While some modern fruit processing industries import mango and citrus pulps and juice concentrates from India, our horticultural produces from hills do not get access to the processing industries due to lack of transportation and other intermediary preservation facilities in the strategic fruit producing belts.

ACTORS OF VALUE ADDITION MARKETS

There are five key actors involved in value product generation to marketing. In technology generation side local/indigenous knowledge of value addition has key role. Many of value added products are based on indigenous knowledge. For e.g. pickles, confectioneries and sour patches from Nepalese hog plum, dried vegetable products (Sinki, gundruk, masyaura, chana etc). Further to this public research organization (Nepal Agricultural Research Council) and universities (AFU and TU) are also involved in technology generation. A few of non-governmental organizations (e. g.Li-Bird) are also involved in technology generation. NARC is involved in fabrication of machine useful for production of value added product (fig 1-4). Further, it is also involved in method development of some new or quality horticulture products (fig 5-8).

The actors involved in technology dissemination is mainly Department of Agriculture (DOA) which has network in all 75 districts of this country. Beside this public organization, a few projects are in operation in few hills and mid hill districts such as HIMALI and HVAP. These projects are time bound (5-6 year), funded by ADB and IFAD; and lead by government official deputed from Ministry of Agriculture Development. There are other programs also working in promotion of value addition of agriculture commodities including horticulture commodities. One village one product (OVOP) and one district one product (ODOP) are two highly successful program running in Nepal implemented by Agro enterprise center (AEC) under Federation of Nepalese Chamber of Commerce and Industry (FNCCI). These programs are good example of public private partnership which has benefited small farmers producing unique Nepalese product. OVOP was initiated in 2006/07 with inclusion of Nepalese hog plum (Lapsi), sweet orange (Junar) and wood apple (bel) along with other non-horticultural products. The OVOP program involves 17 horticulture commodities in 19 districts at present. From year 2010/11 ODOP have been lunched in four districts to promote horticultural processing industries (http://goo.gl/9nLnCv). For e.g. tomato ketchup (Dhading), Junar juice (Ramechhap), Arecanut processing (Jhapa) and ginger processing (Synjha) programs. Beside these, ginger trade competitiveness program is also running in Surkhet district under the umbrella of MOAD, FAO and FNCCI-AEC (http://eifnepal.gov.np/page/29/20).Additionally, value addition of citrus fruit crops in Doti district coordinated by LiBird Nepal (http://goo.gl/2ySGZo) is another example of NGO working in raising livelihood of rural poor with foundation of processing especial pickle manufacturing plant.

There are a number of international non-governmental organizations (UNDP, FAO, SNV) funded programs are in operations (MEDEP, SIMI etc). There programs are working in value chain and sub sector analysis which help government and non-governmental institution on formulation of policies and program appropriate for promotion of horticulture product diversification. For example ginger sub sector analysis (http://eifnepal.gov.np/page/29/20).

A number of small cottage horticulture commodities processing industries are operating in different parts of Nepal. Department of Small and Cottage Industries and Small and Cottage Industry Development Board are playing key role for the establishment and promotion of agro based processing industries in different parts of Nepal. The total figure of such industries are difficult to predict as many of these are operating without registration in informal ways. The Rijal Tashi Company is the first to work with market oriented well established value Addition Company in Nepal (http://www.rijaltashi.com.np/). Dabur Nepal a franchise of Dabur India (http://www.dabur.com/nepal) and Dibya pharmacy of Patangali Ayurved Limited (http://goo.gl/OhWS8z) are other value added product production and marketing giant operating in Nepal. Being impressed with works of such companies and realizing scope of market a number of other processing companies are establishing, however, their economy of scale is very negligible as compared to the big three companies.

TECHNOLOGY AVAILABLE IN NEPAL

There are a number of value added products and their recipes available which are passed from generation to generation. For example, lapsi mada, mango dried pickles (titaura), amala and lapsi dried products, gundruk, sinki, tama (pickled bamboo shoots) etc. These products are suited on Nepalese palate and yet we have to explore their commercial values to international market. Further, due to migration of Nepalese to a number of foreign countries obviously there is niche market of these products in Nepalese occupied parts of the world.

Due to unavailability of small to medium size processing machine Nepalese coffee producers were compelled to sale unfinished coffee bean into international market at low price. Agricultural Engineering Division of NARC has developed two types of medium capacity coffee pulper (manual and electricity operated; 140 kg/ha; Fig. 2 and 3)) (AED, 2011). Similarly, ginger washing machine (Fig. 4) and skin peeler prototypes are in testing phase which could help in producing high quality dried ginger (shutho) in near future (AED, 2014).

Most of Nepalese dried horticulture products are sun dried in open and hygiene of the product is an issue. There are a number of cabinet solar driers available in market which are bulky in nature and cost is very high. Therefore, transporting them to hilly part of countries where possibilities of value added product production in small to medium scale is not feasible. Realizing this constraints NARC has developed low cost plastic solar drier made of UV stabilized tarpaulin sheet and wood which is useful for drying apple slices, lapsi mada and vegetable dried products (AED 2011). This technology is suitable for small scale production. For medium sale processing industries a prototype of walk- in- solar drier is in testing phase (Fig 5). It is made up of UV stabilized plastic sheet and locally available bamboo pole (AED, 2014). This structure is of 2.5 X 5 m in dimension and up to 200 kg of product could be dried at

Fig 2. Hand operated coffee pulper

Fig 3. Machine operated coffee pulper

Fig 4. Ginger washing machine electric operated

Fig 5.Solar tunnel drier

(Source: Agricultural Engineering Division, Nepal Agricultural Research Council, Kathmandu, Nepal)

Fig 6: wine from pear

Fig 7: Kiwi products (juice, wine and dried slices)

Fig 8. Apple Juice from Kalikot

Fig 9. Chip making cultivar (Khumal UJjawal)

(Source: HVAP Department of Agriculture; and FTD and NPRP, Nepal Agricultural Research Council, Kathmandu Nepal) once. It is suitable to dry mushroom, apple slices, spices, coffee beans, cardamom and vegetable dried products. It is reported that 12 -15 kg fresh apple is required to prepare 1 Kg dried apple slice. A part from these better processing machine, a recipes for value added products have been developed by Food Technology Division of NARC (FTD, 2014). For example, banana nectar, potato chips, Kiwi fruit jam and dried slices, and liquor from a number of fruits (kiwi, plum, pear; Fig. 6-9) etc.

Nepalese food habit is changing with migration of Nepalese people to different part of world as well as easy availability of international food due to opening of supermarkets (e.g. Bhatbhateni). For example, pasta, pizza, juice and salads are entering into Nepalese kitchen. Because of this change in food habit import of processed horticulture products (sauces, juice, chips, French fries, canned vegetable in brine) are increasing over years (Table 1). Only looking at the trend of potato chips import (Fig 10) the suitable variety identification (Fig. 9) (NPRP, 2014) and successful operation of chip producing industry in Nepal could reduce outflow of huge sum of Nepalese currency into the international market.

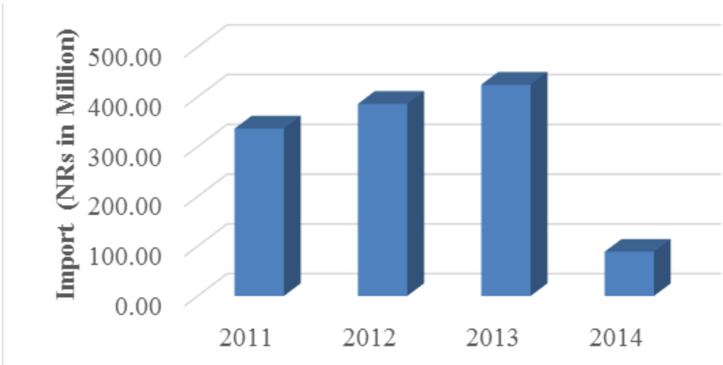

Fig 10.Import of potato chips in Nepalese market over four years (source: MoAD statistical year book)

Success story

There are a few value added successful entrepreneurs in Nepal which are also farmers. A name to cite is Bananna Agro Resort, Kailai operated by Kalu Hamal (http://goo.gl/F1zPrn). Kalu Hamal received award for successful farmer of the year 2015 from the President of Nepal. The Banana resort produces nearly 21 processed banana products (finger chips, pickles, pudding, dumplings, pancakes, salad, juice, wine etc.) all made out of banana. While relaxing under banana thatched hut in the resort you could test these delicacies and you could bask under hot sun of Kailali bearing banana hat while touring around banana resort.

POLICY MEASURE TO PROMOTE VALUE ADDITION OF HORTICULTURAL PRODUCES

The policy measures needed to develop value added products of horticultural origin are as follows; the preservation and processing technology of horticultural produces require establishment of storage facilities for perishable fruits at an elevation range between 5000 to 8000 ft above the sea level to elongate the shelf life of apple, and citrus fruits for at least six months in natural cellar storage without any deterioration in quality and safety. The storage facilities are to accommodate the glut production in the season. Later on this facilitates production of value added products by minimizing postharvest losses and wastages.

- Encourage establishment of preservation of pulp at the production site and transport to the processing industries. the volume and the quantity of the pulp will be decreased thus making easier for transportation
- Provide technical knowhow on enzyme production technology from horticultural substrates by means of biotechnology.
- Develop diversified value added products from horticultural resources and the research funds for such activities should be allocated through competitive grant system to the potential research organizations
- Implement food quality and safety at all levels of processing to comply with international criteria for promoting agro food trade and consumers safety assurance
- Develop indigenous food preservation and processing technology for generating employment and income in the rural areas

RESEARCH AND DEVELOPMENT

- Development of appropriate technology for fruit preservation and processing at different scale of operation suitable to various locations
- Utilization of by-products for production of ingredients like pectin, citric acid, peel oil, vinegar etc.
- Production of high quality products for export promotion and import substitution
- Development of novel fruit products such as probiotic fruit juice and drinks, and various other fruit products admixing with the extracts of medicinal plants having varied therapeutic drinks
- Development and standardization of wine technology for utilizing various horticultural produces for producing white wine, red wine and cider etc.
- Industrialization of pickling industries such as Gundruk , Sinki and Tama for developing value added products by pure culture fermentation process
- Product optimization and Standardization of vegetable pickles for export potential
- Development of process for manufacturing crude enzymes which are essential for juice processing
- Development of appropriate packaging technology for valued added horticultural products
- Dissemination of package services value added processing to the potential entrepreneurs at rural areas through related government bodies and private consulting services.
- Collaborate and identify niche areas of value addition, formulate programs and set up technical working groups. Low cost equipment/ machinery to be developed especially for small farmers.

WAY FORWARD

Nepalese youth forces are heading towards Middle East countries in huge number each year in search of job. With better policy and program to promote in-country horticultural processing industry we could not only substitute the importation but also absorb the youth force in our own countries. Policy on easy credit access to agro-based industries by government of Nepal and directives to Nepalese Banks is another approach. Youth self-employment program is one program which could be better utilized to boost value added industries. Further, there are a number of projects and programs (PACT, HIMALI, NARDF) providing fund for agricultural R and D. These program could positively discriminate horticultural based processing industries while screening proposal for grant program. Recently GoN has ratified Agricultural Development Strategies (ADS) for 20 years (www.moad.gov.np), where one of the component is marketing of agricultural commodities for import substitution. Program on enhancing horticultural based processing industries from ADS is anticipated to harness the potentiality of this sector. Finally, we have our unique Nepalese products and small to medium scale of operation. Therefore, it is always not suitable to introduce and use bigger processing plants from abroad. We need more research work on prototype development and fabrication of machineries based on our scale of production and type of commodities we are manufacturing. Further, while marketing value added product the best manufacturing protocol of the products and branding are essential and research from R and D partners on these aspect and dissemination of the best practice though training and mass media to entrepreneurs are needed.

REFERENCES

AED (2011). Annual report. Agricultural Environment Division, Nepal Agricultural Research Council, Khumaltar, Lalitpur, Nepal.

AED (2014). Annual report. Agricultural Environment Division, Nepal Agricultural Research Council, Khumaltar, Lalitpur, Nepal.

FAO (2006). Postharvest Management of Fruit and Vegetables in the Asia-Pacific Region.

FTD (2014). Annual report. Food Technology Division, Nepal Agricultural Research Council, Khumaltar, Lalitpur, Nepal.

MoAD (2009). Statistical Information of Nepalese Agriculture. Ministry of Agriculture Development, Kathmandu, Nepal

MoAD (2011). Statistical Information of Nepalese Agriculture. Ministry

of Agriculture Development, Kathmandu, Nepal
MoAD (2012). Statistical Information of Nepalese Agriculture. Ministry of Agriculture Development, Kathmandu, Nepal
MoAD (2013). Statistical Information of Nepalese Agriculture. Ministry of Agriculture Development, Kathmandu, Nepal
MoAD (2014). Statistical Information of Nepalese Agriculture. Ministry of Agriculture Development, Kathmandu, Nepal
NPRP (2014). Annual Report. National Potato Research Program, Nepal Agricultural Research Council, Khumaltar, Lalitpur, Nepal.

ROLE OF HORTICULTURE IN POVERTY ALLEVIATION IN NEPAL: AN EXPERIENCE BASED ON MICRO-ENTERPRISE DEVELOPMENT PROGRAMME (MEDEP) IN NEPAL

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ABSTRACT

Nepal is one of the poorest countries in the world but has abundant resources for economic development. In Nepal still 25.2 percent people are living below the absolute poverty line (NRs. 19.261). One of the poverty alleviation programmes of government of Nepal is Micro-Enterprise Development Programme (MEDEP) a joint initiative with Government of Nepal. After piloting in ten districts in the first phase (1998-2003) the results of MEDEP for poverty alleviation were found to be effective and government and UNDP recognized it as Micro-Enterprise Development (MED) Model. MEDEP started creating micro-entrepreneurs in various sectors whichever is potential in any particular location by identifying market demand of the first and then promoting the most potential enterprises there. Its established six circle model was then adapted by Government Nepal at Village Development Committee (VDC), Municipality, District Development Committee (DDC) and at the centre in Ministry of Industry in 2008/09. Since then Government of Nepal has been replicating it gradually and covered 69 districts with its resources and is planning to cover all 75 district by end of 2017. Among more than 150 different kinds of enterprises under seven categories (Industrial policy 2010) such as Agro and Forest Based, Artisan (Handicraft) Based, Service Based, Construction Based, Information and Communication Technology Based, Tourism Based and others that need special permission for establish Agro Based particularly Horticulture Based enterprises have been found friendly to poor people and has played significant role in poverty alleviation.

As of end of September MEDEP has promoted more than 75,000 micro-entrepreneurs (Annual Report, MEDEP 2015) and among about 55 percent are Agro Based enterprises. About 60 percent of 55 percent Agro Based enterprises are horticulture based such As Strawberry Production and Production Processing, Apple Processing, Riverbed Farming, Off-Season and Seasonal Vegetable Production and Marketing, Honey Production and Processing, Vegetable Seeds Production and

Processing, Pear Processing, Plum Processing, Mushroom Production and Processing, etc. The rest of agro based enterprises are dairy, food processing and meat processing. Out them about 5,632 horticulture based micro-entrepreneurs were sampled and field survey were also conducted to verify these data and analysed. The results show that the average total average annual production cost of six horticulture products was NRs. 74,065,311 (US $ 740,653 approx.). The average annual sales value was NRs. 168,739,589 (US $ 1,687,395 approx.) with net average annual income of NRs. 85,647,029 (US $ 856,470 approx.). The average per capita income (PCI) before joining MEDEP was NRs. 8,092 (US $ 81 approx.). With the change in the annual net income their PCI has increased to NRs. 35,978 (US $ 360 approx.) which is significant change in the income status of the Poor and Socially excluded families. They have been able to create employment to 28,978 persons and about 33,993 persons (entrepreneur and her/his family members) have been able to move out of poverty.

INTRODUCTION

Being a naturally beautiful country with series of snowy mountains and numerous beauties from east to west, Nepal attracts large numbers of visitors from other countries. Nepal has huge resource potential but the gap between the availability of resources and its usage is wide. Due to the lack of employment opportunities as well as less number of production oriented activities, Nepal remains one of the poorest (NLSS 2010, CBS) countries in the world. At present bout 25.2 percent of of its population live below the absolute poverty line (Nepal Living Standard Survey 2010) set at Rs. 19,261 (US$ 250) per person per year (Per Capita Income – PCI). Poverty is pervasive and chronic, and this state of pervasiveness is reflected by Nepal's global ranking in the 2014 Human Development Index as 145 out of 187 countries (Human Development Report 2015, UNDP). Since Eighth Five Year Plan the overriding goal of Government of Nepal is to alleviate poverty and plans and programmes are developed and implemented accordingly.

MICRO-ENTERPRISE DEVELOPMENT MODEL

Micro-Enterprise Development Programme (MEDEP) with main objective of poverty alleviation through micro-enterprise development creating off-farm employment and income opportunities for the rural poor and excluded, initiated based on the government's Ninth Five-Years Plan. The joint venture of Government of Nepal and the United Nations Development Programme (UNDP) was initiated in 1998 as a pilot programme in ten districts (1998-2003) of Nepal which advocated promoting self-employment opportunities in the informal sector to reduce the level of poverty amongst those living below the poverty line and socially excluded by engaging them in the micro-enterprise sector. With the success of the piloting phase from for five years the programme was expanded in an additional 25 districts in phase II (2004-2007) and further expanded to 38 districts during the third phase (2008-2013). Currently MEDEP is being implemented its fourth phase (20014-2008) with shift in its main objective of development of institutional capacity of government, micro-entrepreneurs' associations and micro-enterprise service providers fully providing technical support to implement Micro-Enterprise Development for Poverty Alleviation (MEDPA) a government led programme which is replicated in 64 districts and will gradually cover all 75 districts by 2018. for a period of four years from and the programme covered 38 districts in its third phase from 2008 to July 2013. During the first phase UNDP provided budget from its core fund The funding agencies such as DFID, Australian Aid, NZAID, CIDA mobilised resources through United Nations Development Programme (UNDP).

Towards the end of second phase (2006-07) Micro-Enterprise Policy was approved by Government of Nepal. During the same period Maoists joined Government and National Planning Commission (NPC) prepared "Three Year Interim Plan (TYIP - 2007/08 – 2008/09)" and micro-enterprise development for poverty alleviation got high priority. As a result micro-enterprise sector was included in the TYIP with allocation budget by Government of Nepal (GON) in the name of "Micro-Enterprise for Poverty Alleviation (MED-PA)" started allocating budget since 2009/10 in 18 districts. Year 2009/10 was the last year of TYIP and gain NPC developed another TYIP (2010/11 – 2012/13) again giving high priority to micro-enterprise sector. The Thirteenth Plan (2013/14 – 2015/16) recently started and Government of Nepal, Ministry has given high priority for microenterprise development for poverty alleviation.

Ministry of Industry (MOI) is the main implementing agency where as Ministry of Federal Affairs and Local Development (MOFALD), Ministry of Forest and Soil Conservation (MOFC) and Ministry of Agriculture Development (MOAD) are the co-implementing agencies. At the centre there is a Project Board (PB) chaired by MOI and represented by MOFALD, MOFSC, MOAD, Association of Youth Organisation of Nepal (AYON), Federation of Nepalese Chambers of Commerce and Industries (FNCCI), Federation of Nepal Cottage and Small Industries, Nepal Rastra Bank (Central Bank of government), Australian Aid and the UNDP. PB makes policy decision and guide for project implementation. In each district, District Enterprise Development Committee (DEDC), which is chaired by District Development Committee (DDC) Chairperson and backed by other district level government and non-government organizations, takes care for the planning, implementation and monitoring of the programme at district level. Several other organizations at centre and district level are playing their respective roles. MEDEP executes the programme via DEDC through Micro-Enterprise Development Service Providers (MEDSPs) through competitive bidding process applying Result Based Sub-Contracting system.

Target Beneficiaries: The first step of programme implementation is selection of target groups. The primary beneficiaries or target groups of MEDEP are low income families (NLSS 2010) living below the poverty line which is basic criterion and based on this income poverty criterion the following are target groups in proportion.

- Women – 60 percent
- Unemployed Youths - 60 percent
- People from socially excluded and hardcore poor communities
    - Dalits – 30 percent
    - Indigenous Nationalities (Adibashi-Janajaties) – 40 percent,
    - Others (higher castes) – 30 percent
    - Religious Minorities
- Disaster Affected Families
- Conflict Affected Families
- People Living with HIV/AIDS (PLHA) and Injecting Drug Users

(IDUs)
- Poor People of Bhutani Refugee affected communities

Natural Resources and Enterprise Development Potential, Market Demand and Target Group Analysis

The second step of MEDEP implementation is to conduct study on Natural Resource Potential, Market Demands and Target Group Analysis of the newly selected districts. This study will identify the existing natural resources and enterprise development potential in each VDC of the districts in terms of volume of raw materials production, and possibilities of creating number of micro-entrepreneurs or enterprises based on the existing resources, existing skills and appropriate technologies. It also looks for readymade demand of markets of the potential products/ services and screens and selects only those products/services which have market demand. Besides this study also analyses the demographic situation of the VDCs to determine population density of Dalits, Indigenous Nationalities and Ethnic Minorities. MEDEP intervenes in the common area of interface of the three circles (Figure 1). This study/ survey report is shared among the members of the District Enterprise Development Committees (DEDC) chaired by DDC Chairperson. Then DEDC approves the recommendation and findings of this study/survey for implementing MEDEP in the district.

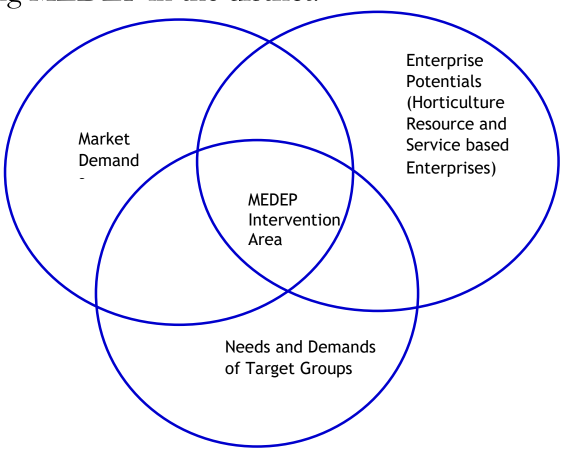

Figure 1: Market demands, enterprise potentials and target group selection

IMPLEMENTATION OF MEDEP MODEL

Social mobilisation is the key to inclusive micro enterprise development for the poor. An Enterprises Development Facilitator (EDF), with support from MEDEP staff members, conduct participatory rural appraisal (PRA) to identify potential target groups and communities. Availability of local resources is also mapped out and market demand is analysed at this stage. Another key element of social mobilisation is to provide orientation to perspective micro entrepreneurs on several aspects, such as basic information about micro enterprises, advantages of working in a cooperative or group, advantages of saving habits, and so on. The districts are selected on the basis of low Human Development Index (HDI) as well as the number of poor people, indigenous communities, Dalits, Madhesi's etc. based on the latest census, while the communities are selected based on natural resources endowments, other enterprise potentials, a rapid market demand analysis and poverty levels. Target groups are selected to ensure 70 % of the Women population, 40 % of the Indigenous People's population, 30% of the Dalits 40 % of the Madhesi's, and 60% of youth (16 to 40 year). The entry point of programme is PRA for wellbeing ranking followed by Household Surveys use forms A, B.C Customer surveys are done with form D while resource endowments use Form F. The logical sequencing of Micro-Enterprise Development (MED) for horticulture based enterprises are presented in Figure 2. Based on the criteria listed and interest indicated the EDF forms the Micro-Entrepreneurs 'Groups (MEGs) comprising 5 to 11 members. If a large number of entrepreneurs are created in a cluster then the Micro-Entrepreneurs Groups are merged and formed a co-operative and there are about 220 co-operatives of micro-entrepreneurs having more than 15,000 members promoted by MEDEP. The uniqueness of MEDEP promoted co-operatives is that each member is running successful business and collectively their volume of production meets the economy of scale for marketing collectively.

Following social mobilisation, the group members are provided with two types of **entrepreneurship development training**. The first type of training is "Enterprise Creation and Development" is imparted to potential entrepreneurs if all participants are literate while "Start and

Improve Your Business" (SIYB) (ILO 2002) is imparted to participants who are barely literate or illiterate. During SIYB training, potential micro-entrepreneurs select their own micro enterprises based on the information provided by EDF. Once a micro-enterprise is selected by potential entrepreneurs, they are provided with **technical skills** which are necessary to develop them into micro-entrepreneurs.

After potential entrepreneurs acquire the required technical skills, they now have to invest start-up capital in the selected micro-enterprise. Groups can use their own saving for investments. If credit is needed, to gain **access to finance,** instead of providing direct financial support, MEDEP facilitates linkages between entrepreneurs and local Financial Service Providers (FSPs). Similarly, MEDEP provides micro-entrepreneurs with *support* to **access to appropriate technology** which is crucial to run and sustain the micro-enterprises. Transfer of appropriate technology often includes user-friendly and low-cost technical skill, equipment, or machinery to a group of entrepreneurs, rather than to individual entrepreneurs. MEDEP makes the links between the Micro-Entrepreneur (ME) and the technology supplier.

Finally, although market demand analysis is done early MEDEP provides support to link the already identified customers with micro-entrepreneurs for **marketing which follows business counselling**. Such support includes, but is not limited to, pricing, labelling, branding and marketing of products for scaling up and graduation of the MEs. Marketing also includes developing linkages between micro-enterprises and small and large enterprises and applying sub-contracting mechanisms. For sustainability of micro-enterprises and their linkages to value chain systems, micro-entrepreneurs are provided with counselling services on a regular basis.

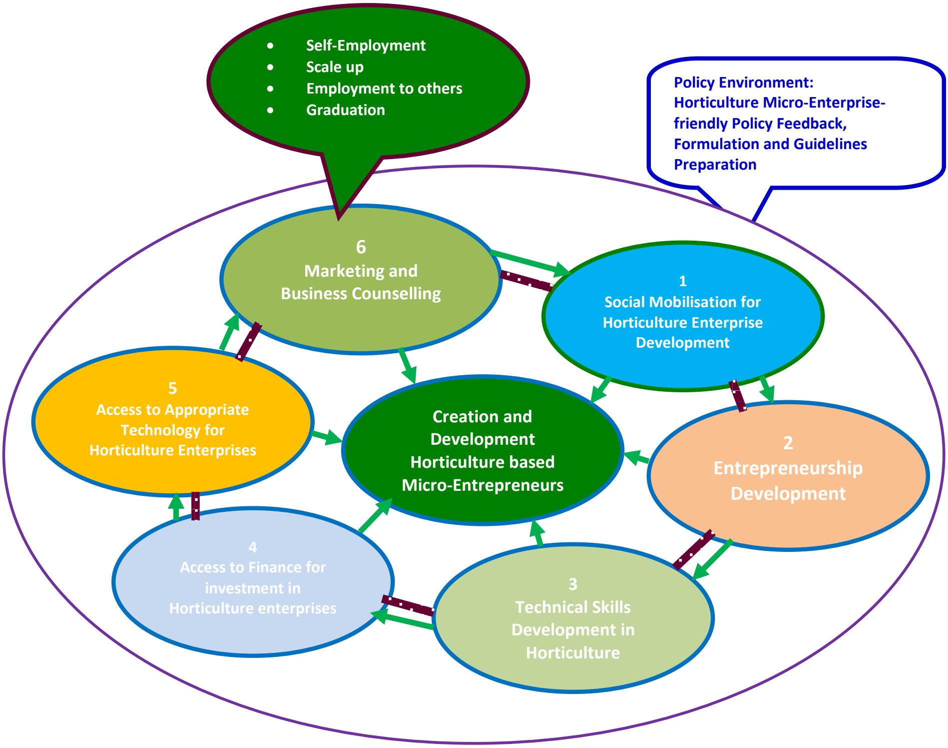

Figure 2: Logical sequencing of horticulture based micro-enterprise development (Pun, L. 2015)

AGRO AND HORTICULTURE-BASED ENTERPRISES

As of end of September MEDEP has promoted more than 75,000 micro-entrepreneurs[1] in seven enterprise categories such as Agro Based, Forest Based, Artisan (Handicraft) Based, Service Based, Tourism Based, Construction Based and Information Technology Based. Among them about 55 percent are Agro Based enterprises. About 60 percent of 55 percent Agro Based enterprises are horticulture based such As Strawberry Production and Production Processing, Apple Processing, Riverbed Farming, Off-Season and Seasonal Vegetable Production and Marketing, Honey Production and Processing, Vegetable Seeds Production and Processing, Pear Processing, Plum Processing, Mushroom Production

1 Management Information System (MIS)/Database of MEDEP 2015.

and Processing, etc. The rest of agro based enterprises are dairy, food processing and meat processing.

EMPIRICAL EVIDENCES OF HORTICULTURE-BASED ENTERPRISES ON POVERTY ALLEVIATION AND IMPACTS ON LIVELIHOODS

About 5,632 horticulture based micro-entrepreneurs were extracted from MEDEP Management Information System (MIS) Database as sample for this articles and field survey were also conducted to verify these data and analysed. The data presented in Table 1 shows that the average total production cost of six horticulture products was NRs. **74,065,311 (US $ 740,653 approx.).** The sales value was NRs. **168,739,589 (US $ 1,687,395 approx.)** with net average annual income of NRs. **85,647,029** (US $ 856,470 approx.). Their average per capita income (PCI) before joining MEDEP was NRs. 8,092 (US $ 81 approx.). With the change in the annual net income their PCI has increased to NRs. 35,978 (US $ 360 approx.) which is significant change in the income status of the Poor and Socially excluded families. They have been able to create employment to 28,978 persons and about 33,993 persons (entrepreneur and her/his family members) have been able to move out of poverty.

While comparing the product-wise increase in per capita income of entrepreneurs then it is observed that strawberry production, processing and marketing has given the highest amount of income to them (about 770% PCI increase) followed by Ginger (658%) and the lowest contribution being from Apple Processing (174%) (Table1). Beekeeping and honey processing have employed the largest number of persons in the business followed by strawberry (12,816) persons) followed by Riverbed Farming (7,026) and the lowest employment by Apple Processing (157). If we compare the contribution of enterprises in lifting the Poor above poverty line then Beekeeping and Honey processing has lifted the highest number of Poor followed by Green Peas and lowest is again Apple Processing. While comparing the the average per capita income (PCI) of entrepreneurs before MEDEP intervention then Green Peas entrepreneurs have the lowest PCI and Ginger Processing entrepreneurs have the highest.

Table 1: Summary of number of entrepreneurs production, sales, profits, percapita income change, number of employment and move out of poverty in five commodities

S. N.	Types of Enterprises	No of entrepreneurs	Average Annual Production cost (NRs)	Average Annual Sales value (NRs.)	Average Annual Profit (NRs)	Average Per Capita Income (PCI) before joining MEDEP (NRs.)	Average Per Capita Income (PCI) after MEDEP intervention (NRs.)	No. of persons employed	No. Person moved out of poverty	Remarks
1	Riverbed Farming (Vegetables)	1,171	5,999,987	16,040,972	10,040,984	8,963	30,400	7,026	7,026	
2	Apple Processing	157	262,239	501,445	262,954	9,307	16,216	157	314	
3	Beekeeping	2,940	5,303,378	32,038,889	17,660,500	8,963	30,400	12,816	2,816	
4	Strawberry	520	26,970,930	50,342,000	23,371,070	5,023	38,660	2,600	2,600	Annual exported to India worth NRs. 14,040.000
5	Green Peas	1,054	34,800,000	67,600,000	32,800,000	4,699	23,883	5,270	0,540	Annual export to India worth NRs. 90,000
6	Ginger Processing	690	728,776	2,216,283	1,511,521	11,595	76,310	697	697	
	Total	6,532	74,065,311	168,739,589	85,647,029	48,550	215,869	28,566	33,993	
	Average		12,344,218	28,123,265	14,274,505	8,092	35,978			

IMPACT OF HORTICULTURE BASED ENTERPRISES IN IMPROVING THE SOCIO-ECONOMIC CONDITIONS OF THE ENTREPRENEURS AND THE COUNTRY

We observed the increase in per capita income and employment creation by six horticultal products in Table 1. With this increase in income of the Poor and Excluded entrepreneurs the following socio-economic impacts have been observed among the entrepreneurs promoted by MEDEP.

- Their average per capita incomes have increased by more than 512 percent (NARMA 2010)
- Brahman, Chhetri, Thakuri and Sanyashi Micro-entrepreneurs contributed 10 percent to family income whereas that of Indigenous Nationalities contributed 20 percent and Dalits 26 percent.
- Women micro-entrepreneurs participation in community institution and social work increased and held decision making position in political parties.
- Participation of women entrepreneurs in VDC, DDC and Municipality meeting increased with ability to raise voices of the voiceless.
- They have been able to send their children in private schools for better education.
- They have been able to access the better health services from the private health service centres.
- Consumption of quality food increased by 40.3 percent.
- Their social status has been increased in the community. One of the entrepreneurs named Ms. Kesha Pariyar, chairperson of National Federation of Micro-Entrepreneurs Nepal (NMEFEN) has won the International Business Peace award. Likewise, more others have won national award such Surya Asha award, etc.
- They have been able to spare time to participate in local community development
- Many of them have been graduated from Micro to Small enterprise and have started paying tax to government.
- Many micro-entrepreneurs products are now being exported such as Strawberry (worth NRs. 14,040,000 annually), Green Peas (NRs.

90,000 annually), Processed honey (mostly Chyuri Honey to India), Bamboo Products, Off-season Vegetables, etc.

POTENTIALS FOR POVERTY ALLEVIATION THROUGH HORTICULTURE BASED ENTERPRISES IN NEPAL

Because of the country's diverse agro-ecological regions available in Nepal there is every possibility of production of high value horticultural crops such as Strawberry, Apple, Beekeeping, Riverbed Farming, Green Peas, Ginger, Seasonal And Off-Season Vegetable, Mushrooms, Kiwi, Vegetable Seeds, etc. and their processed products. These crops are truly suited to poor farmers (small holders and marginalized farmers) as these are high value products. Strawberry production, processing and marketing is a comparatively new venture in Nepal. The history of commercial production of strawberry is not more than one and half decades. The average annual income from this crop is NRs. 100,000 approximately (Pun, L. 2011) and it has very high potential of export to India and processing for frozen peas. Likewise, green pea production in mid hills and mountain areas during rainy-autumn seasons is also a very high potential as it is also a export crops. Farmers plant peas immediately after potato harvest and therefore it has become possible to cultivate two crops in a year in the mid-high hills areas.

In most of the central Terai regions the landless families reside near the river bank and their livelihoods is labour work in the landlord land or work in the road side. MEDEP experience shows that if riverbeds lands distributed to these landless families then they cultivate for farming of high value crops such as cucurbits (water melon, musk melon, bottle gourd, cucumber, etc). There are about 200,000 ha land potential for riverbed farming in Nepal. They can earn on an average NRs 10,000 per Kattha. They can cultivate two crops in the riverbeds as the water level subsides in the riverbed for about nine months from October to June. This has been proven a very potential land for poverty alleviation of landless families settled nearby and along the river banks. Not only MEDEP but also other organizations such as MEDEP, Helvetas, GIZ, Plan International, Forward and Mercy Corps (Riverbed Farming Development Draft Policy 2013). These organizations have formed Riverbed Farming Alliance and working on Riverbed Farming policy that has been submitted to Ministry of Federal Affairs and Local Development (MoFALD).

Vegetable seeds have become anther high potential crop for poverty alleviation as it is most suited to the small and marginalised farmers. Vegetable seeds is also an important export crops.

PRESENT ISSUES AND CHALLENGES

Although horticulture based enterprises have been a high potential sub-sector for poverty alleviation as well as economic growth of the country there are several issues and challenges. A few of them are listed down.

- Fragmented and small land holding that limits farm mechanization
- Difficult terrain making difficult in transportation of agriculture inputs to the production sites and transportation of horticulture products to market
- Poor market network
- Middlemen determining the price and cartel system
- Lack of market assurance of the products
- Limitation of technology dissemination
- Lack of economy of scale production of the products
- Because small scale of raw material production establishment of processing industries have limited scope except micro-enterprises.
- Blanket recommendation of technologies and subsidy schemes for marginalized, small and large farmers which is not marginal and small farmers friendly policy

RECOMMENDATIONS AND SUGGESTIONS

- Technology and subsidy schemes should separate for marginal, small, medium and large farmers. Marginal and small farmers should have better access to subsidy schemes of the government and different package of practices and technologies should be developed for marginal, small, medium and large farmers
- Market infrastructures should be build wherever commercialization of high value crops are possible
- Micro-irrigation and water harvesting technologies available should

be made easily available to marginal and small farmers.

- Rural Market Centres should be promoted as engine of local economic growth.
- Micro-enterprise level horticultural crop processing should be promoted in rural areas.
- Non tariff barriers such as exploitation by middlemen, brokers, should be controlled and there should legal base to discourage such practices.

REFERENCES

Helvetas-Inerswiss Co-operation. 2016. Riverbed Farming in Nepal. Edited by Gautam, K. A documentation on the process and methodology. 2015. Riverbed Alliance

Impact Assessment of MEDEP. 2010.

International Labour Organisation (ILO). 2002. Start and Improve Your Business Level 1 for Rural Nepal. An Entrepreneurship Training Manual adapted to Nepal

MEDEP MIS/Database system 2014/15

Ministry of Industry (2010). Industrial Policy. Annexes 1 to 8.

NARMA. 2010. Independent Impact Assessment of MEDEP

Nepal Living Standard Survey (NLSS), 2010/11, Central Bureau of Statistics (CBS), National Planning Commission (NPC)

Pun, L. 2015. Logical sequencing of horticulture based micro-enterprise development in Nepal

Pun, L. 2017. Micro-Enterprise Development (MED) Model in Nepal.

United Nations Development Programme (UNDP). 2015. Human Development Report. Annex 1

ISSUES RELATED TO HORTICULTURE MARKETING AND TRADE

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ABSTRACT

This paper discuss about the horticulture and issues related to marketing and trade in Nepalese context. According to Wikipedia, 2015; Horticulture is the branch of agriculture that deals with the art, science, technology and business of vegetable garden plant growing. It includes the cultivation of cultivate plant, fruits, vegetables, nuts, seeds, herbs, sprouts, mushrooms, algae, flowers, seaweeds and non-food crops such as grass and ornamental trees and plants. It also includes plant conservation, landscape restoration, landscape and garden design, construction, and maintenance, and arboriculture. Inside agriculture, horticulture contrasts with extensive field farming as well as animal husbandry. Likewise, USDA defined Horticulture as that branch of agriculture concerned with growing plants that are used by people for food, for medicinal purposes, and for aesthetic gratification. Horticulture is divided into specializations.

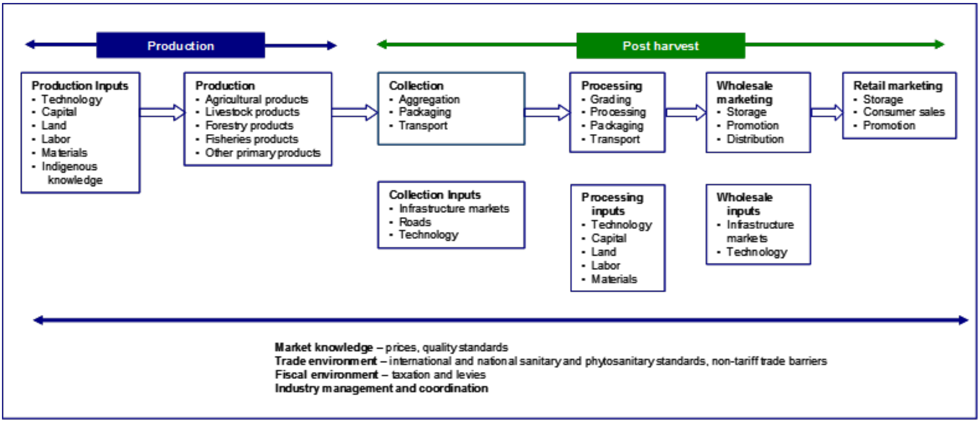
INTRODUCTION

On the other hand, the term marketing has evolved over time; today marketing is based around providing continual benefits to the customer following a transactional exchange. The Chartered Institute of Marketing defined marketing as 'The management process responsible for identifying, anticipating and satisfying customer requirements profitably'. In addition, marketing requires co-ordination, planning, implementation of campaigns and employees with the appropriate skills to ensure marketing success. Marketing objectives, goals and targets have to be monitored and met, competitor strategies analyzed, anticipated and exceeded. Through effective use of market and marketing research an organization should be able to identify the needs and wants of the customer and try to deliver benefits that will enhance or add to the customers lifestyle, while at the same time ensuring that the satisfaction of these needs results in a healthy turnover for the organization. Meanwhile, trade covers the domestic as well as international markets. Trade is the part of the market but in general it denotes the international marketing with tariff.

EXISTING MARKETING SYSTEM IN NEPAL

In Nepal, existing market infrastructure consists of a series of market sites from collection point to wholesale mostly with limited facilities and basic hygiene conditions. Collection centre are typically located at small town situated on the roadside where a number of small traders have set up simple warehouses for both distribution of consumer products and collection of produce. Farmers transport small quantities of produce by whatever means available. Produce is aggregated by the trader and transported to larger markets and buyers when conditions permit. Such facilities are suitable for non-perishable items (e.g. rice and other food crops) but increasing volumes of fresh vegetables more timely market system. The mandi is a wholesale market typically located in a larger urban centre where its main function is as a breakdown and distribution centre for consumer commodities. Usually land is allocated by the municipal authority and basic facilities constructed by traders. The largest wholesale markets are located in Kathmandu, like Kalimati Fruits and Vegetable Development Committee under the Ministry of Agricultural Development and Balkhu Fruits and Vegetable market from private sector. The following Figure 1 explains the existing marketing value chain channel of horticultural and other food crops in Nepal.

Figure 1: Generic Horticultural Production Supply Chain Systems in Nepal

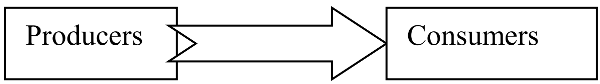


Adopted: ANZDEC Limited, 2007 and Pandey, 2010

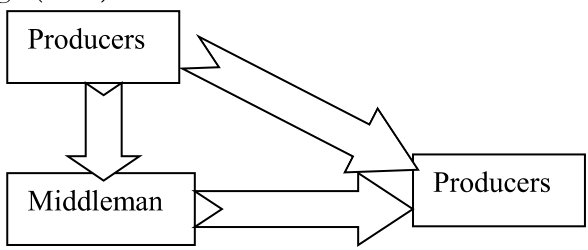
A horticulture marketing channel is a set of practices or activities necessary to transfer the ownership of goods, and to move goods, from the point of production to the point of consumption and, as such, which consists of all the institutions and all the marketing activities in the marketing process.

An alternative term is distribution channel or 'route-to-market'. It is a 'path' or 'pipeline' through which goods and services flow in one direction (from vendor to the consumer), and the payments generated by them flow in the opposite direction (from consumer to the vendor). A marketing channel can be as short as being direct from the vendor to the consumer or may include several inter-connected (usually independent but mutually dependent) intermediaries such as wholesalers, distributors, agents, retailers. Each intermediary receives the item at one pricing point and moves it to the next higher pricing point until it reaches the final buyer. Figure 2 explains the genesis of horticultural marketing in Nepal. In the years of 1987s, which also called as first stage, in which the marketing system was very immature and producers directly sell to the consumers. After 1995s, the introduction of middleman in horticultural and other marketing, where dual systems of marketing channels are exist and the producers can be sold either direct to the consumer or through middleman. In third stage (year 1998s), the farmers groups were established and they production as well as marketing activities have been done. In this stage, the individual producers sell to the products to the farmer's groups and through farmers groups the production will be handover to the retailers and finally to the consumers. Likewise, in fourth stage the producers' product collects either by the middleman or farmer's cooperatives. After collection the horticultural products they sell to the retailers and finally to the consumers. This stage is prevails in horticultural marketing in Nepal so far. In these years, cooperative marketing is more priority for government provided subsidy and supports.

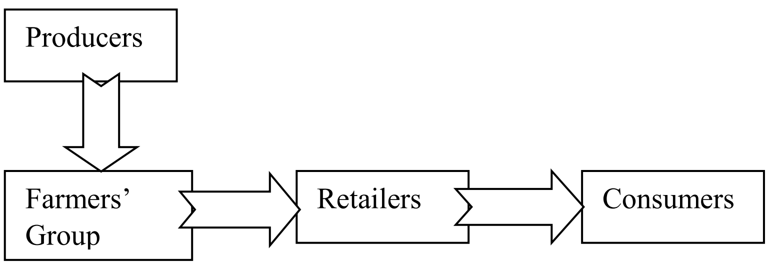
First Stage (1987)



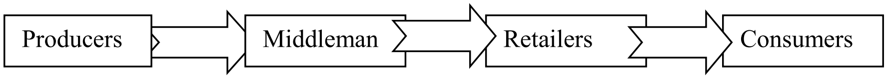
Second Stage (1995)



Third Stage (1998)



Fourth Stage (2000 to date)



Fourth Stage (2006 to date)

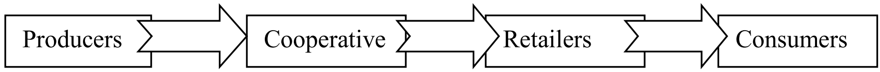


Figure 2: Marketing channel Genesis of off season vegetable in Nepal

MARKET INFORMATION SYSTEM IN HORTICULTURE VALUE CHAIN

Market information systems (otherwise known as market intelligence systems, market information services, or MIS) are planned system of collecting, processing, storing and disseminating data in the form of information needed to carry out the functions of management in horticultural marketing. The horticultural market information may relate to product place, price, promotion etc. Likewise, for the Agricultural marketing, Agriculture Market Information System (AMIS) used in gathering, analyzing and disseminating information about prices and other information relevant to farmers, animal husbandry, traders, processors and others involved in handling agricultural products. Figure 3 explains the flow daigram of existing horticultural market information system and subsystem.

In horticultural marketing in Nepal, Marketing Information System play the key factors to disseminate the information of markets, such as Kalimati fruit and vegetable committee that allows broadcasting wholesale price each day through radio Nepal or television. Likewise some of the FM broadcast price daily and The Kathmandu post or Himalayan times also publish price news daily. The AEC/FNCCI in close support of donor agencies has developed website www.agripricenepal.com where beneficiaries get daily wholesale price. The firm chooses the product, performs distribution function, carries out promotional measures, and lastly the form uses the pricing mechanism. These four elements constitute the marketing mix of the firm and shortly called: Product, Place (distribution), Price and Promotion or 4P and are considered as controllable variables of marketing where the choice of the manager is free.

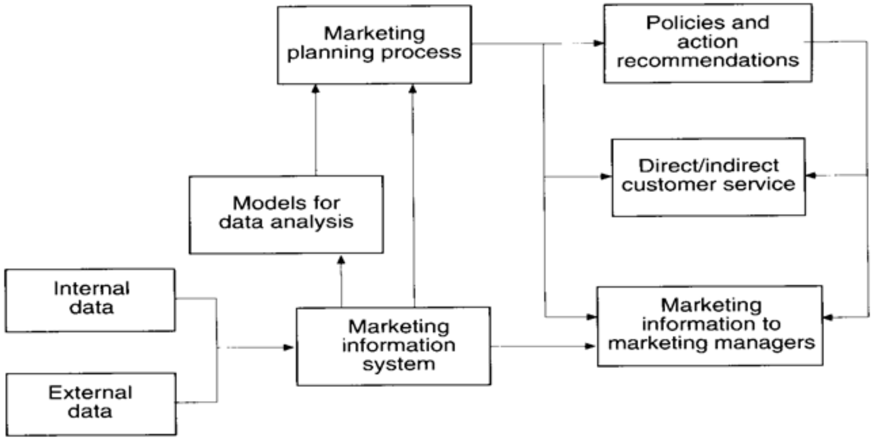


Figure 3: Marketing information systems and its subsystems

Marketing Information System (MIS) can offer critical services for the success of small and big entrepreneurs engaged in the collection, production, processing and trade of agricultural products. The MIS promotes market transparency and good value chain governance and allows local communities benefit from natural products enterprises. It offers valuable information on product quality, price, legal procedures, market requirements and demand and supply situation. The MIS information allows local producers and collectors maintain the consistency of quality expected in the market and enhance their bargaining power as they sell their agricultural products (ANSAB, 2010).

Like, Agricultural marketing, horticulture marketing covers the services involved in moving the product from the farm to the consumer. Numerous interconnected activities are involved in doing this, such as planning production, growing and harvesting, grading, packing, transport, storage, agro- and food processing, distribution, advertising and sale. However, in Nepal, there is very weak interconnection between harvesting to sale activities. Due to very few processing industries of horticultural crops, farmers are reluctant and unsecure for the fruits and vegetable crops.

Table No. 1: Exports and Import scenario of Horticultural crops in F.Y. 2013/2014

Export Chapters (HS Codes)	Description, Commodities	Export Values (Rs.)	Import Values (Rs.)
Chapter 06 (06011000-06042000)	Live trees and other plants: bulbs, roots and the like: cut flowers and ornamental foliage	8,453,292	82,140,624
Chapter 07 (07011000-07139000)	Edible vegetables and certain roots and tubers	2,205,176,903	13,134,677,753
Chapter 08 (08012100-08140000)	Edible fruits and nuts: peel of citrus fruit or melons	4,161,032,798	12,180,582,679
Chapter 14 (14011000-14049090)	Vegetable plaiting materials: vegetable products not elsewhere specified or included	854,356,616	277,682,992
Chapter 20 (20011000-20099000)	Preparation of vegetables, fruits, nuts or other parts of plants	4,447,054,767	1,020,141,397
	Total	11,676,074,376	26,695,225,445

Source: TEPC, 2015

On the other hand, export and import scenario of horticultural crops (see Table 1) shows high differences between export and import trade. Most of the horticultural products are heavily exported from India and rest of the world. It is due to the weak Marketing Information system, lack of standard production for exportable market, lack of ware houses, processing industries, proper transportation facilities with packaging, distribution, advertising and sale policy.

MAJOR ISSUES/ PROBLEMS OF HORTICULTURAL MARKETING AND TRADE

An organized marketing system ensures better returns to the farmer. It also stables the market prices. It protects the interest of both consumers and producers. However, in our case horticultural marketing is not well organized and farmers are facing many problems to sell their products. Considering these obstacles following are the pertinent issues for the horticultural marketing and trade in Nepal.

- Poor quality of Production because of lack of improved seeds and fertilizers. As a result, poor quality of production and low prices in the market. It is necessary for the orientation of good quality production, like production based on Good Agricultural Practices (GAP), Integrated Pest Management (IPM), etc.
- Lack of Transportation Facility is the main obstacle in the way of efficient horticultural marketing. The road condition of rural road network is very poor. Due to lack of road network and poor quality road, most of the horticultural products are wasted and could not fetch satisfactory price.
- The role of middleman should be re-oriented; they are taking big share of farmer's income without doing anything. It seems that, poor farmer borrows the money from them and sells his product at lower rates.
- In case of agricultural commodities the mixing of good and bad products is very common in Nepal, like other developing countries; India and Pakistan. There is no proper method of grading system, which creates a problem of marketing and erode high price in international market.
- The credit facilities are not adequate to meet the farmer's requirement. Recent Government initiation to provide agricultural loan at the rate of 6% also effectively implemented in rural areas. So that, poor farmer impel to borrow the money from private money lenders at high interest rate with tied conditions.
- The collection of product from small farmers is very expensive and a difficult process. It is a great problem for the efficient perishable horticultural marketing and trade.

- Poor ware house facility for the horticultural products is one of the main problem. Due to lack of storage facility farmers are impel to sell their products with low price. It should be provided by the government as well as private organizations, like FNCCI, CNI, etc.
- In Nepal, various parts of weighing and measuring instruments are not properly calibrated. Due to such problem, farmer suffers to get reasonable price and loss the money and time for buying and selling of his product.
- Most of horticultural farmers in Nepal are uneducated and they are very weak about the latest information technology and Market Information System. Thus, they are unable to achieve the real price of his product.
- For the international market, the products should be standard and harmonize with Sanitary and Phyto-sanitory (SPS) measures. In addition, horticultural entrepreneur and trader are facing Non tariff Barriers in different parts of the country.
- Like SPS problem, Technical Barrier to Trade (TBT) also one of the major problem for international standard calibration, packaging, trade mark, etc.

SUGGESTIONS AND RECOMMENDATIONS OF THE EFFICIENT HORTICULTURAL MARKETING AND TRADE IN NEPAL

- Based on the different studies and authors own experiences following would be the major suggestions and solutions for the efficient horticultural marketing and trade in Nepal.
- Consumer is the king in agribusiness, thus the purpose of the business is to create more customers so that the market need to consider willingness to pay (WTP) capacity of the customers. In this connection, there should be orientation of the consumers as well as product diversification.
- There should be integrated management action in horticultural products. All the different functions of the products must be tightly integrated with one another, keeping marketing as the pivot leaving a favourable impact on the consumer. All the quantity flow and

quality under control leaving within prescribed budget as a value chain system.

- The horticultural entrepreneur should take Consumer satisfaction as the prime objective. It leads to satisfaction of the consumer meeting his/her ends within the means of product.
- The government should emphasize the road facilities and rural areas should be linked with the markets/collection centres. It will enable the farmer to sell his/her product in the market directly in the hands of consumers.
- The government should increase the credit facilities to the small farmers. No doubt all the commercial banks are providing this facility to the farmers but still it is not sufficient and not easily access to the farmers and entrepreneurs.
- The government should provide loan for the ware house and develop improved warehouse with banking facilities. The government should also construct the multi-chamber cold storage to keep the stocks of various goods in Public private partnership approach.
- The government should improve the market system in the country. Market committee should be reorganized and Markets inspectors should regularly monitor the prices of agricultural products. The strict laws should be introduced and followed to the concern persons.
- The government should build the new markets near the producing centres, pocket package area, etc. It will enable the farmer to get proper price and reward. Such type of market facilities should be build with stakeholder participation from the beginning of the project.
- Market demand and supply condition can be provided to the framers through radio, T.V and newspaper. So, the government should pay special attention to the Agricultural Marketing information System.
- In horticultural products grading is very important. There are various agencies which are directly and indirectly involved in grading of the horticultural products. However, there is a need to re-organize and interlinked for effective of marketing system.
- The government should allocate a sufficient amount on marketing

research to make the horticultural marketing more effective and demand oriented.

CONCLUSION

Horticulture marketing and trade is the key issue for the effective entrepreneurship. Strong linkages and effective communication related to market information (prices and standards, supply and demand information) between stakeholders along the system is necessary for the marketing function efficiently. The primary mechanisms for enhancing marketing and value chain performance are by (i) reducing costs at any point along the value chain, (ii) differentiating products by making them uniquely attractive to the consumer, and (iii) introducing appropriate technology at any point in the value chain system (iv) improving the performance and collaboration between stakeholder organisations involved in the value chain. The overall business environment has been severely disrupted by an unstable peace and order situation, which has also hampered the ability of the government to deliver its development programs and necessary infrastructure investments and the confidence of the private sector to invest in processing and marketing facilities. The challenge for fruits and vegetable with other agriculture commercialisation in Nepal is therefore to create mechanisms for working with industry stakeholders to plan and manage the commercialisation processes by focussing on individual value chain systems and their linkages in marketing. Finally, it is most urgent need to materialize plan in action with our own situation.

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REFERENCES

Acharya S.S and Agarwal NL, 2006. Agricultural Marketing in India. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi

Binayee, Surya B., 2005. An overview of agriculture marketing information system (MIS) in South Asia, Asia Network for Sustainable Agriculture and Bioresources (ANSAB), May 2005.

Kahlon, A.S and Tyagi.D S, 1983. Agricultural Price Policy in India. Allied Publishers Pvt. Ltd., New Delhi.

http://www.citeman.com/352-role-of-middlemen.html#ixzz2HTWokyPG

https://en.wikipedia.org/wiki/Horticulturehttp

Pandey, P.R. 2010. Sustainable Development Challenges of a Diverse and Vulnerable Rice Industry in Nepal (Unpublished PhD Dissertation); Tokyo University of Agriculture and Technology, Tokyo, Japan. ://en.wikipedia.org/wiki/Horticulture2002.

Phillip Kotler (1996). the marketing social cause "the American marketing Association I.C Achumba (1994) the new marketing concept.

WOMEN IN HORTICULTURE

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ABSTRACT

Women are the key player in the development of horticultural crop in Nepal. They are mainly involved in vegetable production. Floriculture is also a part of their life for religious purpose. Their participation in fruit farming is also at remarkable level. From recent past, horticultural crops are commercialized and converted as cash crops. Many governmental as well as non-governmental organizations have implemented income generation programs through commercialization of horticultural crops targeting women. Floriculture is lead by private sector where women's involvement is visible.
There is very few data available about women's involvement in horticulture sector. However, Ministry of Agricultural Development (MoAD) record shows that 44.1 % women are engaged in vegetable, potato and spice production.47.7 % in fruit farming and 34.6 % are involved in youth targeted commercial vegetable production program. In addition, Floriculture Association of Nepal (FAN) shows that women's contributions in floriculture constitute more than 60 % and similar record found in tea sector as well. Their participation in coffee production has reached to 45% (CoPP).

BACKGRUOND

Agriculture is the mainstay of Nepalese economy contributing about one-third (32.6%) to GDP (AICC, 2015).Integrated farming with mixed crop, poultry and livestock is the characteristic of Nepalese agriculture and widely prevalent in the country, irrespective of agro-ecological regions(FAO, 2010).Both men and women contribute significantly to farming systems however, women make substantial contribution in agriculture sector. According to the Ministry of Agriculture Development (MoAD), 72.8 % of women and 60.2 % of men were engaged in agricultural activities in 2010 (MoAD 2010). The percentage share of women to agriculture sector is 12.6% higher than that of men.

After the establishment of Women Farmer Development Division (WFDD) under MoAD, two major objectives were set to give emphasis on women participation in agricultural development programs. Primarily, identifying specific programs appropriate for women and given emphasis to implement these programs. Beside this, creating agro based income generating employment opportunities to develop women entrepreneurship was the second major objectives. Income generating programs such as vegetable production, sericulture, bee keeping, etc were taken into consideration. Since then the district level offices under the MoAD are implementing these activities through formation of specific women groups or mixed groups. Similarly, Five Years Strategic Plan for Women Farmers Development of Nepal (1994-1999) was developed and implemented by the WFDD and this strategy provided space for women farmers' enrolment in cereals, horticulture, small livestock and poultry production.

Agriculture Perspective Plan (APP) identified agriculture sector as the driving force to trigger the economic development. APP spelt out the incorporation of gender issues in every possible program throughout the process of agricultural development. In this regard APP emphasized the significant role of women labor force in the production of high value commodities such as sericulture, vegetable and livestock. Also gave special priority in enhancing women farmers' access in improved technology, extension service and agricultural loan. Further the APP elaborated space for increasing women farmers' participation through specific women groups in vegetable production and other sectors like sericulture, bee keeping etc.

MoAD is implementing the National Agricultural Policy-2004; in which emphasis is given to the "empowerment of women" especially women from disadvantaged groups through targeted programs. The Tenth Plan 2003 envisages gender equitable outcome of agricultural development interventions ensuring40% participation of women in overall agricultural activities and 60% participation in vegetable, horticulture and sericulture production activities (NPC (2005).

The nature and extent of women involvement in agriculture also varies greatly from region to region and ecological sub-zones. Women are involved in most of the farming and related activities besides their exclusive involvement in domestic responsibilities. Traditionally, women do the exclusively tedious, time and labor intensive works like sowing, transplanting, weeding and intercultural operations, harvesting, threshing, transportation and post harvest operations like shelling, cleaning, grading and processing etc. After the harvest, rural women are almost entirely responsible for storage, handling, stocking and processing. So women are important partners in agriculture work force.

There has been increasing trend of share of horticultural crops over the past few years. Traditional farming of several horticultural crops are now being commercialized and several new entreprises have been emerging in horticuture sector (Poudyal and Acharya, 2013). On the other hand several studies shows that there is increasing trend of women's participation in this sector. Central Beuro of Statistics (CBS) of Nepal reflects that women's participation in agriculture labour force has increased from 36% in 1981 to 45% in 1991 and further made a jump to 48.1% in 2001. This indicates that agriculture is being highly feminized in recent years (FAO 2010). Women in other countries, play a much more significant role in horticultural crop production compared to staple crops. Women are the principal producers of most horticultural crops in developing countries and are predominantly involved in the value-addition activities from production to marketing (GHI 2007).For example in Bangladesh, women account for 48% of all labor in vegetable production compared to 11-20% for cereal production (Rahman, 2000; cited in GHI 2007). Throughout the developing countries of Africa, women play a dominant role in the production of horticultural crops and cultivate more than half of the total smallholdings(GHI 2007).

Besides creating jobs on the farm, the horticultural sector also generates off-farm employment, especially for women. This is the case for export and value-added processing industries, which are important sectors of the economies of Latin America and Africa. In Mexico, 80-90% of people engaged in packing operations are women, and even higher percentages of women workers are involved in fresh produce field operations. Evidence from Africa reflects a similar trend: women comprise 91 % of horticultural employees in Zimbabwe (Dolan and

Sorby,2003; cited in GHI 2007).

WOMEN INVOLVEMENT IN HORTICULTURE IN NEPAL

Women's involvement in Kitchen Garden (KG) is very traditional and since time immemorial in Nepal. They are responsible for the production of mainly vegetables and some fruits in KG for the household consumption. Since last few years, horticultural crops are commercialized and becoming a source of income generation activities for the farmer. Both government and non-governmental organizations have implemented horticultural program as a livelihood improvement program.

Following programs shows the participation of women in horticultural development programs in Nepal.

Women Participation in Vegetables, Potato and Spices Program

Vegetable farming is not a new topic in these modern days and not just for the consumption in the family but also for income-generation. Especially in urban and peri-urban areas and road corridors, vegetable gardening seems one of the productive enterprises for income generation. Vegetable growers get higher profit margin compared to that of cereal crops. Government as well as other development organizations are implementing vegetable production program as an income generation activities targeting for women groups for the improvement of their livelihoods.

Fig 1: Woman working in vegetable field

Thus, women's involvement in vegetable farming is very noteworthy. Following table depicts the women's participation in Vegetables, Potato and Spices Program under MoAD.

Table 1: Women Participation in Vegetables, Potato and Spices Program

SN	Development Regions	Women Participation(%)
1.	Regional Agriculture Directorate, Eastern Region	39.8
2	Regional Agriculture Directorate, Central Region	48.0
3	Regional Agriculture Directorate, Western Region	47.9
4	Regional Agriculture Directorate, Mid-Western Region	49.7
5	Regional Agriculture Directorate, Far-Western Region	40.3
	Average	44.1

Source: MoAD 2070/71

This program mainly covers the activities like Seed Potato Self-sufficiency Program, Off-season Vegetable Production, Ginger Promotion Program and other programs associated with Vegetable and Spices crop promotion. These programs are implemented by District Agriculture Development Offices (DADOs) with the technical and financial support from Technical Directorates and associated National Program Offices. Regional Agricultural Directorates are involved in monitoring and supervision of the activities. The above table shows that women's participation in vegetables, potato and spices program is 44.1 %. Their participation is highest (49.7%) in mid-western region where as minimum (39.8%) in eastern region.

Several studies have indicated that women's participation in commercial vegetable farming is higher than their male counterparts in almost all the activities. Women are more active than men in vegetable production and marketing (Kunwar 2001). This helps generate income for rural women and has raise their socio-economic status in the society. The enhanced social and economic status of women leads to greater household food and nutrition security (IFPRI,2005; cited in GHI). In addition to the financial benefits of horticultural production, increasing women's access to vegetables and fruits for themselves and their families, will improve their health and work performance (GHI 2007).

Women Participation in Fruit Development Program

Fruit Development Program covers activities implemented by DADOs. The program covers both fruit farming in kitchen garden and commercial farming where sapling distribution, training, orchard management campaign and their post harvest activities are included. Women participation in these activities in 5 different regions is presented in table below.

Fig 2: woman observed her fruit tree

Table 2: Women participation in Fruit development programs

SN	Development Regions	Women Participation (%)
1.	Regional Agriculture Directorate, Eastern Region	49.4
2	Regional Agriculture Directorate, Central Region	47.0
3	Regional Agriculture Directorate, Western Region	43.4
4	Regional Agriculture Directorate, Mid-Western Region	45.5
5	Regional Agriculture Directorate, Far-Western Region	53.0
	Average	47.7

Source: MoAD 2070/71

The table above indicates that women's participation ranges from 45.5% (in mid-western region) to 53 % (in Far-western region). An average participation of women in fruit production is 47.7%which reveals that women's participation in this sector is also remarkable.

Women participation in Youth Targeted Commercial Vegetables Production Program

This program is initiated by Vegetable Development Directorate (VDD) since 2070/71 and implemented through DADOs. This program is implemented in 75 districts and total no. of youth benefited from the program is presented in table below.

Table 3: Women participation in Youth Targeted Commercial Vegetables Production Program

SN	Development Regions	Women Participation (%)
1.	Regional Agriculture Directorate, Eastern Region	34.5
2	Regional Agriculture Directorate, Central Region	25.6
3	Regional Agriculture Directorate, Western Region	48.0
4	Regional Agriculture Directorate, Mid-Western Region	19.4
5	Regional Agriculture Directorate, Far-Western Region	45.5
	Average	34.6

Source: MoAD 2070/71

The table reveals that total no. of youth farmer involved in the commercial vegetable production is 5059 where 1565 are women farmers which constitute 34.6%. Women participation in this program is slightly lower than other horticultural programs implemented in the district level. Thus commercialization of vegetable farming, gender role and its impact on women is really important to consider while implementing the program.

Women's involvement in Coffee farming

Coffee though is second largest commodity next to petroleum traded in the international market. It is relatively new crop for Nepal in comparison to other crops like vegetables, fruits and staple food. Coffee was entered in Nepal in 1939 AD. Its production is potential in mid hills of 41 districts but commercial cultivation has been done in 21 districts of Central and Western Development Regions. Based on the data available from Coffee Promotion Program (CoPP) of Helvetas Swiss Inter-cooperation Nepal, 1750 ha is covered by coffee where almost

Fig 3: Woman working in coffee farm her fruit tree

30,000 farmers are involved. The Figure below shows the women's participation in coffee sub sector.

The figure shows the data of women's involvement in coffee farmingfor three years. Women's participation in this sector seems in increasing trend where it was 38 % in FY 2069/70 and continuously increased to 40% in 2070/71 and reached to 45 % in 2071/72.

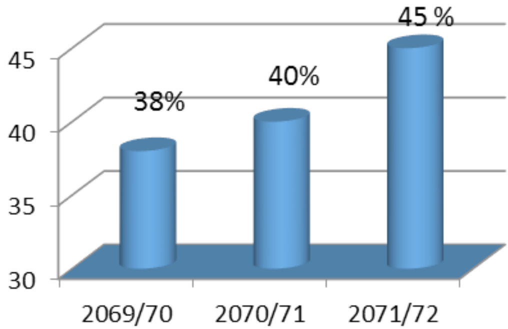

Fig 4 : Womens involvement in Coffee farming

Source: CoPP 2014

Women involvement in Tea farming

Tea industry in Nepal is growing rapidly due to the active participation of private sector. There is a huge international market for both Orthodox and CTC tea. Now tea is grown around 20,120 hectares of land in Eastern and Central development regions (NTCDB 2014). Tea industry is also a firm step towards empowering women as it generates good employment opportunities for women. The tea industry in Nepal provides employment to over 25000 workers with high participation of women. More than 60% of the workers employed in the tea industry are women (Thapa 2005).

Fig 5: Woman in harvesting tea leaves

Women involvement in Floriculture

Floriculture sub-sector grew recently with the increasing demand and supply in the domestic as well as international markets.The study conducted by Floriculture Association of Nepal (FAN) in 2007 reveals that there are 550 active growers in 34 districts. These farms and their networks altogether give employment to about 2500 people and more than 60% of them are women.

Fig 6: Woman busy in marketing

CONCLUSIONS

Throughout the history of Nepal, women have been crucial contributors to horticultural production and currently playing a significant role in commercial production in all sub-sectors as well. However, their involvement in commercial vegetable production is lower than other sub-sectors which need to consider during program planning stage in order to increase their involvement because women are the primary producers and providers of food for their family at household level. They are responsible for family nutrition which can easily be available from horticultural crops.

REFERENCES

AICC, 2072. Agriculture Diary 2072, Agriculture Information and Communication Center, Hariharbhawan, Lalitpur.

CoPP, 2014. Annual Progress Reports2014, Coffee Promotion Program, HELVETAS Swiss Inter-cooperation Nepal, Bakhundole, Lalitpur.

FAO 2010. Integration of Gender in Agriculture: An Analysis of Situation, Food and Agriculture Organization of the United Nations UN Complex, Pulchowk, Nepal, June 2010

GHI, 2007. Global Horticulture Initiative, Strategic Plan, Version 3

Kunwar, Amar Bahadur (2001). A Prospect of Vegetable Farming in an Urban Fringe. A thesis submitted to the Department of Geography, PNC (T.U.), Pokhara, Nepal.

MoAD, 2010. Selected Indicators of Nepalese Agriculture and Population: Ministry of Agricultural Development (MoAD), Government of Nepal.

MoAD, 2014. Gender Equity and Social Inclusion Annual Progress Report 2070/71, Ministry of Agricultural Development (MoAD), Government of Nepal.

NPC 2005. On the Road to Freedom from Poverty, An Assessment of Implementation of the Tenth Plan (PRSP), Second Progress Report

NTCDB, 2014. Tea Statistics 2013/14, National Tea and Coffee Development Board, www.teacoffee.gov.np

Poudyal B. and Acharya L. 2013. Reformation of Horticultural Institutions in Nepal; Proceeding of 8th national Horticulture Seninar 2013, Nepal Horticulture Socity

Thapa ANS, 2005. Concept Paper on Study of Nepalese Tea Industry -Vision 2020

SYNCHRONIZATION OF HORTICULTURE WITH ENVIRONMENT AND HUMAN BEING

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ABSTRACT

This paper is devoted to an overview of literatures related to the alienation or synchronization of Horticulture with respect to environment, biodiversity, climate change, and human health; and to warn the people for miss use of its production technology, safe disposal of its products and overall management of the human life as well as its ecosystem. Horticulture has many dimensions of applications in human life and creation of sustainable environment. Plants and natural landscapes may enhance human well-being by causing positive physiological and psychological responses, by affecting human behaviour or by modifying physical factors of the environment such as relative humidity of the air. Interaction with plants, both passive and active, can change human attitudes; behaviors, and physiological responses.

The recent surge of interest in combination with a great increase of horticultural activities in treatment programs have led to the use of numerous terms for these programs and activities such as therapeutic horticulture, garden therapy, social horticulture, and therapeutic gardening to name a few. Specifically, horticulture ameliorates oxygen production, carbon sinks, pollution amelioration, indoor air quality improvements, water management and erosion control, plants in ecological sewage and wastewater treatment systems, wildlife attraction and preservation, windbreaks and noise amelioration, urban shade, green space and location of plants. Although horticulture plants have ability to sequester carbon to mitigate the increases in carbon dioxide concentrations "greenhouse gas" in the atmosphere that contributing to the increase in the average global temperature; greenhouse production technology and its products consumption patterns should be considered. Rooftop greenhouses (RTGs) had a larger environmental impact than industrial greenhouses. Greenhouse structures in urban areas may face strict reinforcement, stability and security requirements. As a result, the greenhouse structure of RTGs may have larger environmental burdens than current horticulture production technologies. Horticulture has multidimensional prospects in relation with environment/sustainable ecosystem and human being,

livelihood and income generation, natural resource management and conservation agriculture and soil and water conservation.

INTRODUCTION

Horticulture is the branch of agriculture that deals with the art, science, technology and business of vegetables, garden plant growing, and fruits. It includes the cultivation of medicinal plant, fruits, vegetables, nuts, seeds, herbs, sprouts, mushrooms, algae, flowers, seaweeds, non-food crops such as grass and ornamental trees and plants. It also includes plant conservation, landscape restoration, landscape and garden design, construction, and maintenance, and arboriculture. Horticulturists apply their knowledge, skills, and technologies used to grow intensively produced plants for human food and non-food uses and for personal or social needs. Their work involves plant propagation and cultivation with the aim of improving plant growth, yields, quality, nutritional value, and resistance to insects, diseases, and environmental stresses. They work as gardeners, growers, therapists, designers, and technical advisors in the food and non-food sectors of horticulture (Wikipedia, 2015).

Over the past decade many people have become aware of the positive benefits of human interaction with plants and gardens. Trees and plants have been labeled as the "lungs of cities" (McPherson, 2005) because they have the ability to remove contaminants from the air that is breathed. Urban agriculture (UA) is spreading over the urban areas of developed countries in response to a growing awareness of the environmental impact of food systems (Cohen et al., 2012). The urbanization of the world is reducing the connectivity humans have with the natural environment (Worldwatch Institute, 2007). Despite human disconnectedness from the natural world, plants continue to provide environmental benefits at every spatial level: global, local and individual. Protected cultivation is one of the high technologies which is modern, less environment dependent, capital intensive, and has capacity not only to increase the productivity by many fold but also it improve the quality of horticultural crops markedly. There is tremendous development has taken place in the last decades in the field of protected cultivation. Day by day the cultivable land is becoming scarce due to the pressure of population, rapid urbanization, and industrialization. So, it is necessary to increase the productivity of horticulture crops in a sustainable way.

This paper is devoted to an overview of literatures so far review related to the alienation or synchronization of Horticulture with respect to environment, biodiversity, climate change, and human health; and to warn the people for miss use of its production technology, safe disposal of its products and overall management of the human life as well as its ecosystem. Several research papers, proceedings, symposium reports, annals and pertinent websites are searched and studied to prepare this article.

PROSPECTS AND SYNCHRONIZATION OF HORTICULTURE

The Horticulture has many dimensions of applications in human life and creation of sustainable environment. Many of them corroborates directly and some supports indirectly. The figure 1 demonstrated the various dimensions of horticulture in prospects of environment and income generation.

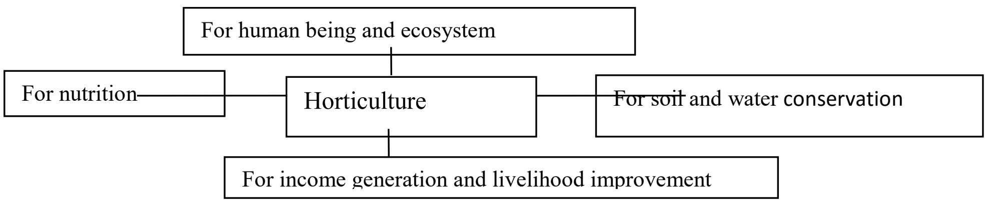

Figure 1: Prospects of horticulture in view with environment and human needs

Horticulture for human being and ecosystem

From health point of view, everybody should eat at least five portions of fruit or vegetables/person/day to help reduce the risk of some cancers, heart disease and many other chronic conditions. This works out as about 400g a day, a recommendation in line with that set by the World Health Organization (WHO/FAO, 2003). Horticulture products are most important to daily living. Human body requires vitamins, minerals, proteins, energy for healths which all are supplied by horticultural crops. Fruits and vegetables are the chief sources of vitamins, minerals, carbohydrates, fats, proteins and are recognized as protective foods as they are necessary for the maintenance of human health.

Plants and natural landscapes may enhance human well-being by causing positive physiological and psychological responses, by affecting human behaviour or by modifying physical factors of the environment such as relative humidity of the air (Relf and Lohr, 2003). Positive responses to plants are observed in perception of pain (Lohr and Pearson-Mims 2000; Diette et al., 2003; Park et al., 2004) and also in perceived health status (Fjeld, 2000).

Plants in indoor environments may contribute to human well-being by raising the relative humidity of the air, and reducing levels of gaseous contaminants and dust accumulation. Too dry indoor air represents a major problem for some workers (Koivunen, 2003). Plants can raise relative humidity to levels recommended for human comfort by transpiration of water through stomata. The amount of airborne micro-organisms does not increase when plants are added to the space. In a study conducted in a hospital radiology department no changes in content of fungi or fungal spores were recorded after introducing plants (Fjeld, 2000). Improved pain tolerance when seeing plants or natural landscapes may derive from the strong attention holding capacity of nature.

Oxygen releasing plants during night

Gives off oxygen at night while most plants produce oxygen during the day; it is perfect for bedroom, family room, garden or other spots that get a lot of evening action (GK., 2009). Some of the most promising oxygen releasing plants during night are Areca Palm, Chrismas Cactus (Schlumbergeras), Rama Tulsi (Tulsi), Neem Tree, Sansevieria/Snake Plant, Sprouts, Epipremnum aureum (golden pothos, hunter's robe, ivy arum, money plant, silver vine, Solomon Islands ivy/taro vine), Amazon Sword, Monstera, Cestrum nocturnum, Tillandsia, Aloe Vera plants, Bromeliads, Ficus religiosa, Peace lily, Cactus and Orchids. There are two types of orchids that were tested in a NASA research study that were mentioned as being very good on their nighttime oxygen-releasing list.

These were the Moth and the Dendrobium Orchids. Moth Orchid is also good at removing certain chemical gases from the air. Dendrobium Orchid, besides giving off oxygen at night, according to the NASA study, this plant is moderately effective at removing such toxins as formaldehyde and chloroform from the air.

Parks and Recreation

Parks provide opportunities for a variety of physical activities and different organized and personal sports, as well as passive activities such as bird watching and communing with nature. Along with providing the associated health benefits, the scenery in the park also has an impact on the level of use (Bedimo-Rung et al., 2005) and the segments of the population to which the park appeals. Thus, ornamental plants have a role in providing or building the environment in which these physical activities can occur and the associated benefits can be achieved.

Interior plants are common in many homes, work places, and commercial settings. Interior scaping is widespread in the hospitality industry, where its presence has been shown to boost occupancy rates and generate profit. Intuitively, people sense that contact with plants and nature is restorative and calming to the human spirit.

Interaction with plants, both passive and active, can change human attitudes; behaviors, and physiological responses. The stress-reducing benefits of passively viewing plants in natural settings are well documented; Accounts of studies conducted in Germany in the 1960s assert that improved employee morale, decreased absenteeism, and increased worker efficiency result when plants are added to office spaces compared to traditional, unplanted offices (Lohr et al., 1996).

Horticulture for nutrition

Nutrition, food security and sufficient family incomes are challenges in many parts of the world. Half the world's people live in rural areas in developing countries. Because hunger and malnutrition are often linked to poverty, providing economic opportunities through horticultural production not only helps family incomes, but also addresses food security and nutrition. Training women to produce and market horticultural crops in the developing world also helps provide a much-needed income stream for families with children. Fruits and vegetables improve nutrient absorption in a diet. Food products better accepted and possibly more sustainable than vitamin supplements or pharmaceuticals.

Horticulture for livelihood improvement

Horticulture farming is mainly carried out by two groups of persons: a) The owners of land who also provide all the other factors of production-labour, capital and entrepreneurship and are therefore rewarded for all factors of production and b) The labourers who mainly provide the labour resources and are therefore rewarded with the wages/salaries. Community managed micro-enterprises; introduction and production of high-value niche products and services; capacity and awareness raising; and access to resources, technologies, and markets could be strategies to mainstream economic activities. There are numerous findings of social benefits of horticultural plants including i) Improve social integration (Kweon et al., 1998) ii) Increase social interaction (Perrins-Margalis et al., 2000) iii) Provide for healthier patterns of social functioning iv) Improved group cohesiveness.

Therapeutic Horticulture

Therapeutic horticulture is a process that uses plants and plant-related activities through which participants strive to improve their well-being through active or passive involvement. In a therapeutic horticulture program, goals are not clinically defined and documented but the leader will have training in the use of horticulture as a medium for human well-being. This type of program may be found in a wide variety of healthcare, rehabilitative, and residential settings (AHTA, 2012). In the early 1990's, there were few examples. Today, examples exist in most cities in public and private settings. American Horticulture Therapy Association (AHTA) developed the first therapeutic garden characteristics in 1995 and awarded the first Therapeutic Garden Design Award in 1997. AHTA has collaborated with the American Society of Landscape Architects (ASLA) on the development of healing gardens across the country. The recent surge of interest in combination with a great increase of horticultural activities in treatment programs have led to the use of numerous terms for these programs and activities such as therapeutic horticulture, garden therapy, social horticulture, and therapeutic gardening to name a few.

Types of Gardens with Respect to Health

Healing Gardens: Healing gardens are plant dominated environments including green plants, flowers, water, and other aspects of nature. They are generally associated with hospitals and other healthcare settings, designated as healing gardens by the facility and designed to have beneficial effects on most users. A healing garden is designed as a retreat and a place of respite for clients, visitors, and staff and to be used at their desire. Healing gardens may be further divided into specific types of gardens including therapeutic gardens, horticultural therapy gardens, and restorative gardens. These garden types are likely to have overlap and the following definitions should be regarded as guidelines since no two gardens are the same.

Therapeutic Gardens: A therapeutic garden is designed for use as a component of a treatment program such as occupational therapy, physical therapy, or horticultural therapy programs and can be considered as a subcategory of a healing garden. A garden can be described as being therapeutic in nature when it has been designed to meet the needs of a specific user or population. It is designed to accommodate client treatment goals and may provide for both horticultural and non-horticultural activities. A therapeutic garden may exist on its own as an extension of an indoor therapeutic program area or it may be part of a larger healing garden.

Horticultural Therapy Gardens: A horticultural therapy garden is a type of therapeutic garden to accommodate client treatment goals, but it is designed to support primarily horticultural activities. A horticultural therapy garden is also designed in such a manner that the clients themselves are able to take care of plant material in the garden.

Restorative Gardens: A restoration or meditation garden may be a public or private garden that is not necessarily associated with a healthcare setting. This type of garden employs the restorative value of nature to provide an environment conducive to mental repose, stress-reduction, emotional recovery, and the enhancement of mental and physical energy.

The design of a restorative garden focuses on the psychological, physical, and social needs of the users.

Cognitive Benefits of horticulture plants

There are numerous findings of cognitive benefits of horticultural plants including i) enhance cognitive functioning ii) Improve concentration (Wells, 2000; Taylor et al., 2001) iii) Stimulate memory iv) Improve goal achievement v) Improve attentional capacity (Ulrich, 1999; Taylor et al., 2001).

Psychological Benefits of horticulture plants

There are numerous findings of psychological benefits of horticultural plants including i) Improve quality of life (Waliczek et al., 1996) ii) Increase self-esteem (Smith and Aldous, 1994) iii) Improve sense of well-being (Kaplan, 2001; Jarrott et al., 2002; Barnicle and Stoelzle Midden 2003; Hartig, 2003) iv) Reduce stress (Whitehouse et al., 2001; Rodiek, 2002) v) Improve mood (Whitehouse et al., 2001) vi) Decrease anxiety (Mooney and Milstein, 1994) vii) Alleviate depression (Mooney and Milstein, 1994) viii) Increase sense of control ix) Improve sense of personal worth (Smith and Aldous, 1994) x) Increase feelings of calm and relaxation xi) Increase sense of stability (Pothukuchi and Bickes, 2001) xii) Improve personal satisfaction (Smith and Aldous, 1994; Pothukuchi and Bickes, 2001) xiii) Increase sense of pride and accomplishment (Matsuo, 1995)

Social Benefits

There are numerous findings of social benefits of horticultural plants including i) Improve social integration (Kweon et al., 1998) ii) Increase social interaction iii) Provide for healthier patterns of social functioning iv) Improved group cohesiveness.

Physical Benefits

There are numerous findings of physical benefits of horticultural plants including i) Improve immune response (Ulrich, 1999) ii) Decrease stress (Rodiek, 2002) iii) Decrease heart rate (Wichrowski et al., 2005) iv)

Promote physical health (Kweon et al., 1998; Rodiek, 2002) v) Improve fine and gross motor skills and eye-hand coordination.

Environmental Benefits of Ornamental Horticulture

Specifically, it ameliorates oxygen production, carbon sinks, pollution amelioration, indoor air quality improvements, water management and erosion control, plants in ecological sewage and wastewater treatment systems, wildlife attraction and preservation, windbreaks and noise amelioration, urban shade, green space and location of plants. On average, a tree can produce 260 pounds of oxygen per year and two mature trees can produce sufficient oxygen for a family of four (Environment Canada, 2005).

Plants' ability to sequester carbon is an important process that can be used to mitigate the increases in carbon dioxide concentrations in the atmosphere that has been occurring since the industrial revolution. Carbon dioxide is a "greenhouse gas" and as such is contributing to the increase in the average global temperature. These changes are very likely to cause significant changes in climates around the world. Concentrations of carbon dioxide in the atmosphere have been increasing at an alarming rate, mainly due to the burning of fossil fuels but also due to changing land uses. To counter this trend, green spaces (or large trees) are planted in public rights of way, parks and open spaces in order to build the global availability of "carbon sinks" (McPherson, 2005).

Acting as natural filters and reducing air pollution, it has been shown that plants generate health benefits by reducing the mortality rate and reducing visits to the hospital (Powe and Willis, 2004). A few ways in which plants reduce air pollution are as follows (McPherson, 2005):

- Absorption of gaseous pollutants through their leaves, e.g., ozone, nitrogen oxides, and sulphur dioxide.
- Further reducing ozone concentrations at ground level by reducing the temperature via evapotranspiration as mentioned above.
- Collection of dust, ash, pollen and other particulate matter on their leaves hence reducing its presence in the air breathed.
- Releasing of oxygen, as mentioned above, which increases the quality of the air for human use.

Use in Medicine

Botany and medicine have been closely linked for most of recorded time. Hippocrates, it is said, coined the word "physician" from the Greek physis, meaning nature, to separate pharmacy from sorcery (Watson, 1994). In addition, traditional Chinese herbal medicine is based on the use of a rich and diverse flora to treat the whole body in an effort to restore harmony and balance between the five elements of fire, wood, earth, metal and water. Plants are used extensively in medicine, both for treatment and preventative measures. In fact, the World Health Organization places 80% of the world's population as dependant on traditional medicine involving plant materials (Watson, 1994). Certain ornamental plants have been the source of modern medicines of significant economic benefits. The common foxglove is the source of digitalis used to treat congestive heart failure. Black poplar and white willow bark and leaves contain salicin the prototypical aspirin from which acetylsalicylic acid was derived. Aloe juice provides instant relief for minor burns and wounds and is used as a salve for radiation burns.

Mythical and Folkloric Benefits

According to ancient myth and folkloric belief, plants and trees provide many benefits which enhance human well-being. An article written by Biley (2001) provides folkloric evidence of the benefits of trees in hospital settings. The article describes different types of trees that could be planted in hospital grounds where patients, visitors, and staff could benefit not only from the aesthetic appeal of the trees but also from their mythical powers (Biley, 2001).

Reductions in Aggression and Violence

In 2001, Kuo and Sullivan published research within a relatively unexplored area -the effects of natural environments on aggression and violence. The research explored whether natural elements such as trees and grasses decreased aggression and violence of inner city urban public housing residents in Chicago, USA (Brethour et al., 2007).

Horticulture for soil and water conservation

Tree based farming offers excellent opportunities because of several advantages. The major advantages of tree based farming are the ability of tree species to withstand harsh agro-ecological conditions such as moisture stress and tolerance to various degrees of salinity. Trees have the ability to establish on poor soils and improve the soil productivity through deep root system, recharging of ground water, recycling of mineral nutrients from lower profiles of the ground, contribution of organic matter and improvement of micro-climate by providing shade and checking the wind velocity. In these perspectives, horticultural crops have capacity for soil and water conservation.

HORTICULTURE, GHG EMISSIONS AND CLIMATE CHANGE

Although Horticulture plants have ability to sequester carbon to mitigate the increases in carbon dioxide concentrations "greenhouse gas" in the atmosphere that contributing to the increase in the average global temperature; the following farming technology and its products consumption patterns should be considered.

Rooftop farming and greenhouse production

Greenhouse production involves a wide range of produce, such as vegetables, fruits, flowers, bedding plants and ornamental plants. Off-season production, increased land and water use efficiency, improved pest control, better produce quality and increased yield due to optimisation of growth factors such as temperature and CO2 concentration are advantages achieved by greenhouse production (Wittwer and Castilla, 1995). However, possible impacts may be on the external environment include pollution of air, groundwater/surface water and the land on which the greenhouse is built and wastes from the operation. A poor occupational environment can have a negative effect on workers' health, and possibly produce quality. Other problems such as emissions of light (van't Ooster et al., 2008; Hanel, 2006), disposal of solid wastes such as used growing media (Alsanius et al., 2010), plastic mulches and plant residues and impact on the landscape have also been mentioned in connection with greenhouse horticulture.

Within the multiple forms of building-based Urban agriculture (UA), rooftop farming is the most common since rooftops are currently unused spaces that can be occupied and revalorized. Rooftop Greenhouses (RTGs) are built on the rooftop of buildings devoted to, mostly, horticulture production.

The global warming potential (GWP) of a RTG structure is of 2.50 kg of CO2 eq., considering the functional unit of 1m2 for a timeframe of 1 year. The impact is mostly associated to the materials stage (including materials extraction, materials processing, transportation, and maintenance requirements) which contributes up to 99% on the global warming potential. The energy consumption during the construction phase and the transportation to the waste management site had, thus, a little impact on the entire life cycle of the structure. Consequently, the implementation of greenhouses on buildings has no large differences with industrial greenhouses on rural areas regarding their construction requirements.

In comparison to the industrial system, the global warming potential of an RTG structure resulted 81% more impacting than for a multi-tunnel greenhouse, while the cumulative energy demand was 53% higher. Main differences among the structures are of resources consumption for the materials. The RTG must accomplish more restrictive laws due to their situation in urban areas (e.g., security and resistance of building structures) and in height (e.g., wind resistance). For instance, the steel requirements per m2 are 5 times higher in an RTG than in a multi-tunnel (Schenck and Huizenga, 2014).

Rooftop greenhouses (RTGs) had a larger environmental impact than industrial greenhouses. The main cause of the results was the law requirements in the urban context, which lead into an increase in the materials use in order to ensure the stability and resistance of RTGs. The environmental impact of horticultural production in RTGs is sensitive to the crop yield and, thus, showed benefits or negative impacts when compared with the production in a multi-tunnel greenhouse. Moreover, the integration of the RTG flows with the metabolism of the building can benefit the horticultural production by reducing the impact of water consumption (e.g., rainwater harvesting in building's roof) or increasing the crop yield (e.g., energy and CO_2 exchange).

Greenhouse structures in urban areas may face strict reinforcement, stability and security requirements. As a result, the greenhouse structure of Rooftop Greenhouses (RTGs) may have larger environmental burdens than current horticulture production technologies. The production of 1 kg of tomato in RTG has a global warming potential of between 178 and 297 g of CO_2 eq., depending on the crop yield. The RTG structure is the most contributor to the global warming potential (GWP) (56.2%), a fact that is commonplace in horticultural systems (Torrellas et al., 2012), because of the large amount of materials consumed (e.g., steel and polycarbonate). Fertilizers and auxiliary equipment contribute to 22.8% and 17.1% of the GWP, respectively, since there is little energy and inputs consumption rather than fertilizers and water in an unheated greenhouse (Torrellas et al., 2012). Pesticides and waste management are the least contributors to the GWP value (<4%). The cumulative energy demand of 1 kg of tomato produced in an RTG is of between 2.9 and 4.8 MJ, depending on the crop yield, and the distribution of the impact among the life cycle stages follows a similar pattern as for the GWP indicator.

Products consumption pattern

Figure 2 gives the answers whether changes to our overall pattern of consumption are likely to make a difference to overall food related greenhouse gas emissions. The other embedded answer is whether changes in the way we consume fruit and vegetables (what we eat and how we store and consume them) will have an effect. Policy makers worldwide increasingly believe that change in what and how we consume is essential if we are to achieve more sustainable patterns of development. The implication of these findings might therefore be that eating fewer meat and dairy products is the single most helpful behavioural shift one might need to make. A reduction in the consumption of sugary and other arguably unnecessary foods could also make a smaller but nevertheless useful contribution. To substitute for the meat and dairy produce, more would need to be eaten of other foods, such as vegetables and carbohydrates (Kramer et al., 1999).

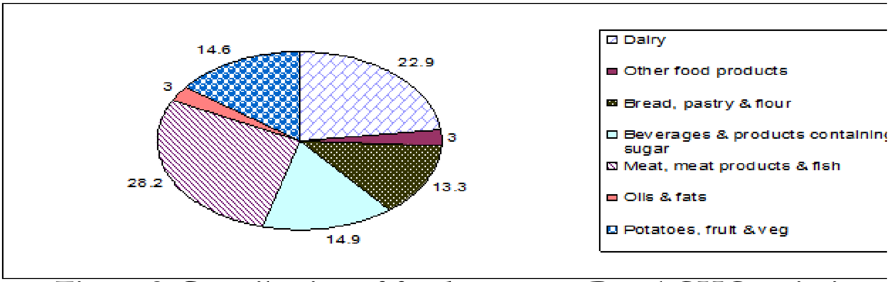

Figure 2: Contribution of food groups to DutchGHG emissions KG/CO2.

Moderate increases in fruit and vegetable intake to around five a day would be unlikely to generate a substitution effect. However a substantial increase in fruit and vegetable consumption might produce this substitution effect and this in turn could decrease emissions from other food sectors. Whether overall emissions from the fruit and vegetable sector would increase a little, substantially, stay the same or decline depends not just on how much fruit and vegetable intakes increase but also on the kinds of fruits and vegetables which are eaten. Less meat but more air freighted produce may well not lead to reductions in food chain GHG emissions.

Horticulture Natural resource management strategy

Horticulture Natural Resource Management (NRM) Strategy enables horticultural industries to deal with environmental matters in the economic and social context in which growers operate. It helps ensure that industry approaches are efficient and effective, and that they are understood, and supported, by external stakeholders (e.g governments). The Strategy enables horticulture to manage the environmental agenda as it affects the industry's future (HAL, 2006).

The issues to be considered by a Horticulture NRM Strategy include:

- global matters such as greenhouse and climate change, and market access;
- national issues such as the COAG Water Reforms and food safety;
- State or regional concerns such as environmental regulations affecting water allocations or native vegetation management; and

- local or property level management issues such as pest and disease control, nutrients and soil health.

There are a number of compelling issues and forces that highlight the need for a Horticulture NRM Strategy. They include water (access to, and efficient use of, suitable quality and quantities of water-and ensuring local water resources are not adversely affected by operations e.g. insufficient environmental flow or contamination by chemicals, nutrients or sediments), soil (maintaining the physical, chemical and biological properties of soil to ensure they are fertile and productive and that soils are not lost through erosion or are causing off-site effects such as dust, sedimentation or nutrient pollution), air (ensuring operations do not unduly disturb neighbours and minimize the generation of greenhouse gases e.g. energy use, cultivation and fertilizer management), native biodiversity (minimizing any negative impacts on native biodiversity, managing production losses from native animals, and optimizing contributions to the local environment e.g. using native plants for integrated pest control and as windbreaks and buffers, or establishing nesting boxes in wetlands), biosecurity (ensuring pests, diseases and weeds are not introduced to, or escape from, horticultural properties e.g. using integrated pest and disease management to reduce reliance on chemicals, and vetting the introduction of new plant varieties), changing land use (contributing to land development policies and controls to ensure growers are able to continue operations, the introduction of new technologies and the development of additional lands), capacity building (ensuring growers and industries have sufficient understanding and adequate resources to manage environmental issues within a commercial production context), NRM planning (ensuring industry leaders are involved in, and contribute to, regional NRM planning and programs), sustainable business operations (maintaining the productive base-healthy soils and water supplies, is a primary requirement for a successful horticultural enterprise.

Using inputs efficiently (water, nutrients and chemicals) can optimize gross margins and reduce risks to the environment. Modern horticultural enterprises are significant investments; their operations can't afford to be undermined by a declining resource base for environmental breaches.

Horticulture with grocery products and pesticides use

Analyses of top-level household environmental impacts show the production and sale of grocery products to contribute between 21-33% to household consumption GHG emissions and approximately 24% to abiotic resource depletion impacts (Tukker et al., 2006).

The subsequent findings from detailed assessments of grocery product impacts indicate that the following groups of product (listed alphabetically) are dominant with regard to the potential environmental impact (GHG emissions, embedded energy, water) associated with UK consumption.

- Alcoholic drinks: Cider and perry; Lager; Spirits; Wine
- Ambient: Breakfast cereals; Canned fish and seafood; Canned meat products; Canned vegetables, soups, pasta and noodles; Cat food and dog food; Chocolate; Coffee; Crisps (potato); Processed snacks; Rice; Sugar confectionery; Tea
- Bakery: Biscuits (sweet); Bread and rolls; Cakes, pastries and morning goods
- Dairy: Butter; Cheese; Milk and cream; Yogurt

The environmental horticulture industry is composed of related commodities including greenhouse, nursery, and turf grass crops, as well as the services associated with their use. Many of these operations are located in or near urban areas to reduce transportation costs. Pesticides have been the primary method of pest control for years, and growers and landscape managers depend upon them to control insect and disease-causing pests effectively and economically. However, pesticides and fertilizers are important pollutants of surface waters in urban areas.

HORTICULTURE IN NEPAL

Horticultural crops; mainly vegetable, spices, fruit and flower, are prime sector of Nepal ranked third after agronomical and livestock resources in farmers' preferences (MoAD, 2015). The increased production and consumption of fruits and vegetables, with their wide adaptation and providers of important nutrients (especially vitamins and minerals), offer promise for the future. Fruits and vegetables as food and diet supplements are gaining momentum in Nepal. In addition, recent experimental evidence has shown the growing importance of fruits and vegetables in the prevention of non-communicable diseases. Further, horticulture would play an important role in urban and peri-urban agriculture and development.

In Nepal, Horticulture has ample role in economic generation, livelihood management, nutritional and environmental management. In Agriculture Gross Domestic Product (AGDP), Horticulture contributes nearly one third part of it as in Figure 3 (MoAD, 2015)

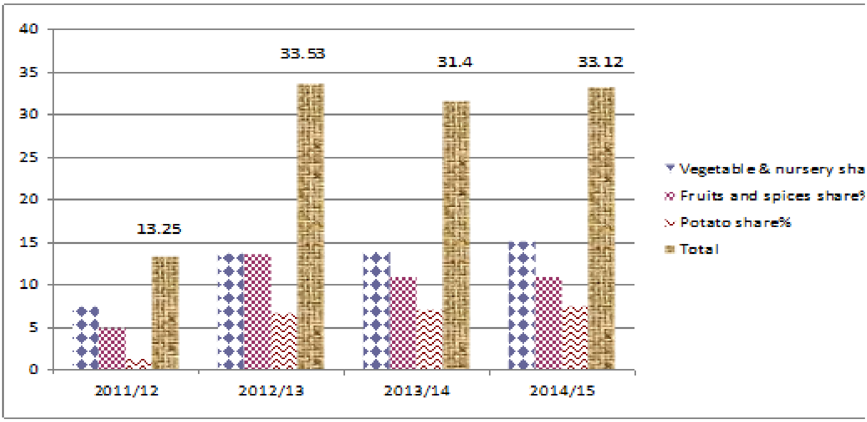

Figure 3: Share of horticultural crops in national AGDP

In these perspectives, Government of Nepal has provided clear guidelines for promoting Horticulture production and productivity focusing export promotion and import substitution program. Moreover, government institutions also highlighted the maintenance of old orchards, establishment of new orchards, parks and commercial vegetable production pockets in different agro-ecological belt.

CONCLUSION

Horticulture has multidimensional prospects in relation with environment and sustainable ecosystem, livelihood and income generation, natural resource management and conservation agriculture and soil and water conservation. In recent years the therapeutic horticulture, ornamental horticulture and rooftop gardening have given ample opportunities to reduce GHGs emissions and climate change impact. In fast growing cities of world and even in Nepal, the pollution less/free area is establishing for improvement of human health as well as recreational purposes. Moreover, the horticulture has many dimensions regarding human health, nutrition and environment; it will be supportive for sustainable agriculture development.

REFERENCES

AHTA (American Horticultural Therapy Association). 2012. Definitions and Positions. American Horticultural Therapy Association

Alsanius, B.W., W. Wohanka, G. Kritz, and D. Waechter, 2010. Som jorden handbok om odlingssubstrat. Alnarp ISBN 978-91-86197-773.

Barnicle, T. and K. Midden, 2003. The effects of a horticulture activity program on the psychological wellbeing of older people in a long-term care facility. HortTechnology 13: 81-85.

Bedimo-Rung, A. L., A. J. Mowen, and D. A. Cohen. 2005. The Significance of Parks to Physical Activity and Public Health- A Conceptual Model. American Journal of Preventive Medicine 28 (2S2): 159-168. Retrieved Feb. 22, 2007.

Biley, F. C. 2001. Utilizing the Mythical and Folkloric Power of Trees in the Modern Hospital Environment. Complementary Therapies in Nursing and Midwifery 7: 207-210.

Brethour, C., G. Watson, B. Sparling, D. Bucknell, and T.L.Moore. 2007. Literature Review of Documented Health and Environmental Benefits Derived from Ornamental Horticulture Products. Final report, George Morris Centre, Canada.

Cohen N, K. Reynolds, and R. Sanghvi. 2012. Five Borough Farm: Seeding the Future of Urban Agriculture in New York City. 169.

Diette, G., N. Lechtzin, E. Haponik, A. Devrotes, and H. Rubin. 2003. Distraction therapy with nature sights and sounds reduces pain during fl exible bronchoscopy. Chest 123: 941-948.

Environment Canada. 2005. You Asked Us. http://www.ec.gc.ca/envirozine/english/issues/58/any_questions_e.cfm.

Fjeld, T. 2000. The effect of interior planting on health and discomfort among workers and school children. HortTechnology 10: 46-52.

GK (Govan Kilgour). 2009. Bringing oxygen producing plants into your home is a way to mimic the healthy lifestyle factors of longevity in humans from the longest lived cultures. Secrets of longevity. www.secrets-of-longevity.com.

HAL (Horticulture Australia Ltd). 2006. Managing the environmental agenda for horticulture, Horticulture Natural Resource Management Strategy Horticulture Australia Ltd, Level 1, 50 Carrington St, Sydney, NSW. 2000.

Hanel, A. 2006. The increase in light pollution in central Europe. In: Proceedings of The Dark-Skies symposium, Portsmouth. pp. 26-31: British Astronomical Association.

Hartig, T. 2003. Restorative environments: Guest editor's introduction. Environment and Behavior 33 (4), 475-479.

Jarrott, S.E., H.R. Kwack, and D. Relf. 2002. An observational assessment of a dementia-specific horticultural therapy program. HortTechnology 12(3), 402- 410.

Kaplan, R. 2001. The nature of the view from home: Psychological benefits. Environment and Behavior 33 (4), 507-542.

Koivunen, T. 2003. Hyva elinympäristo, Sisailmaston ongelmat. In: Rappe, E., Linden, L. and Koivunen, T. (eds.). Puisto, puutarha ja hyvinvointi. Helsinki, Viherymparistoliitto. pp. 61-78.

Kramer, K.J., H.C. Moll, S. Nonhebel, and H.C. Wilting. 1999. Greenhouse gas emissions related to Dutch food consumption, Energy Policy 27, 203-216, Elsevier Publications

Kuo, F. E. and W. C. Sullivan. 2001. Aggression and Violence in the Inner City: Effects of Environment Via Mental Fatigue. Environment and Behaviour 33 (4): 543-571.

Kweon, B.S., W.C. Sullivan and A.R. Wiley. 1998. Green common spaces and the social integration of inner-city older adults. Environment and Behavior 30(6), 832-858.

Lohr, V. and C. Pearson-Mims. 2000. Physical discomfort may be reduced in the presence of interior plants. HortTechnology 10: 53-58.

Lohr, V.I., C. H. Pearson-Mims and G.K. Goodwin. 1996. Interior plants may improve worker productivity and reduce stress in a windowless environment. Environ.Hort. 14(2): 97-100.

Matsuo, E. 1995. Horticulture helps us to live as human beings: Providing balance and harmony in our behavior and thought and life worth living. Acta Horticulturae 391:19–30.

McPherson, E. G. 2005. Trees With Benefits. American Nurseryman April 1: 34-40.

MoAD, 2015. Statistical Information on Nepalese Agriculture. Ministry of Agricultural Development, Singha Durbar, Kathmandu.

Mooney, P. F. and S.L. Milstein. 1994. Assessing the benefi ts of a therapeutic horticulture program for seniors in intermediate care. In: Francis, M., Lindsey, P., and Rice, J.S. (eds.). The healing dimensions of people-plant relations: Proceedings of a research symposium. Center for Design Research, Department of Environmental Design, University of California. pp. 173-187.

Park, S.-H., R. H. Mattson and E. Kim. 2004. Pain tolerance effects of ornamental plants in a simulatedho spital patient room. Acta Horticulture 639: 241-247.

Perrins-Margalis, N., J. Rugletic, N. Schepis, H. Stepanski, and M. Walsh. 2000. The immediate effects of group-based horticulture on the quality of life of persons with chronic mental illness. Occupational Therapy in Mental Health 16(1), 15-30.

Pothukuchi, K. and J. Bickes. 2001. Youth nutrition gardens in Detroit: A report on benefits, potential, and challenges. Detroit, MI: Wayne State University.

Powe, N. A. and K. G. Willis. 2004. Mortality and Morbidity Benefits of Air Pollution (SO2 and PM10) Absorption Attributable to Woodland in Britain. Journal of Environmental Management 70 (2): 119-128.

Relf, D. and V. Lohr. 2003. Human issues in horticulture. HortScience 38: 984-993.

Rodiek, S. 2002. Influence of an outdoor garden on mood and stress in older persons. Journal of Therapeutic Horticulture 13: pp13-21.

Schenck, R. and D. Huizenga (Eds.). 2014. Proceedings of the 9th International Conference on Life Cycle Assessment in the Agri-Food Sector (LCA Food 2014), 8-10 October 2014, San Francisco, USA. ACLCA, Vashon, WA, USA.

Smith, D.V. and D.E. Aldous. 1994. Effect of therapeutic horticulture on the self-concept of the mildly intellectually disabled student. In M. Francis, P. Lindsay and R.J. Stone (Eds.), The healing dimension of people-plant relations: Proceedings of a research symposium (pp.215-221). University of CA.

Taylor, A.F., F.E. Kuo and W.C. Sullivan. 2001. Coping with ADD: The surprising connection to green play settings. Environment and Behavior 33:54–77.

Torrellas M., A. Anton and M. Ruijs. 2012. Environmental and economic assessment of protected crops in four European scenarios. J Clean Prod 28:45–55.

Tukker, A, G. Huppes, J. Guinee, R. Heijungs, A. de Koning, L. van Oers, S. Suh, T. Geerken, M. Van Holderbeke, B. Jansen, P. Nielsen. 2006. Environmental Impact of Products (EIPRO) - Analysis of the life cycle environmental impacts related to the final consumption of the EU-25. Annex Report. http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=1429

Ulrich, R. S. 1999. Effects of gardens on health outcomes: theory and research. In: Marcus, C. C. and Barnes, M. (eds.). Healing gardens. New York, John Wiley and Sons, Inc. pp. 27-86.

van't Ooster, A., E.J. van Henten, E.G.O.N. Janssen, and E. Bongaerts. 2008. Use of supplementary lighting top screens and effects on greenhouse climate and return investment. Acta Horticulturae 801, 645-652.

Waliczek, T.M., R.H. Mattson and J.M. Zajicek. 1996. Benefits of community gardening to quality of life issues. Journal of Environmental Horticulture 14:204–209.

Watson, G. 1994. Associated Medical Services Medicinal Garden. In N. Track, Canada's Royal Garden, Portraits and Reflections, 105-108. Toronto, Ontario: Penguin Group.

Wells, N.M. 2000. At home with nature: Effects of "greenness" on

children's cognitive functioning. Environment and Behavior 32:775–795.
Whitehouse, S., J.W. Varni, M. Seid, C. Cooper-Marcus, M.J. Ensberg, J.R. Jacobs, and R.S. Mehlenbeck. 2001. Evaluating a children's hospital garden environment: Utilization and consumer satisfaction. Journal of Environmental Psychology 21: 301-314.
WHO/FAO. 2003. Diet, nutrition and the prevention of chronic diseases, WHO Technical Report Series 916, Report of a Joint WHO/FAO Expert Consultation, Geneva 2003, http://whqlibdoc.who.int/trs/WHO_TRS_916.pdf).
Wichrowski, M., J. Whiteson, F. Haas, A. Mola, and M. Rey. 2005. Effects of horticultural therapy on mood and heart rate in patients participating in an inpatient cardiopulmonary rehabilitation program. Journal of Cardiopulmonary Rehabilitation 25(5), 270-274.
Wikipedia, 2015. Horticulture. www.en.wikipedia.org/wiki/Horticulture
Wittwer, S. and N. Castilla. 1995. Protected cultivation of horticultural crops, worldwide HortTechnology 5, 6-23.
Worldwatch Institute. 2007. Cities Key to Tackling Poverty and Climate Change. www.worldwatch.org/node/4839.