Precision and Protected Horticulture in Nepal: Sustainability and Future Needs

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Abstract

This paper highlighted the Strengths, Weaknesses, Opportunities, and Threats (SWOT) of precision and protected horticulture development in Nepal and future needs. Precision horticulture and protected horticulture are emerging field of technologies to modernize Nepalese agriculture. Precision horticulture is a holistic system while protected horticulture comes under it. This technology has very good potential especially in urban and peri-urban areas of Nepal for commercial production of horticultural commodities. Population growth, depleting natural resources, and climate change impact on agriculture force to think about modern technologies for horticulture production. Research showed that cultivation under protected structure can increase productivity by 3-5 folds over normal cultivation in high value crops like tomatoes and capsicum. Now days' bamboo plastic house, galvanized iron (GI) tunnels, naturally ventilated greenhouse, hi-tech and semi hi-tech green houses, and net houses have been widely used in Nepalese horticulture for saplings/seedlings production. Lack of area specific technology, less use of information technology along with poor technology development and adoption, weak production and post-production along with improper care and maintenance of structures are considered as major setbacks for its development. Policies and programs for input support, technology development, verification and adoption are the major future needs identified in Nepalese context.

Keywords: Precision agriculture, Protected horticulture, Growing structures, SWOT

INTRODUCTION

Strengths, weaknesses, opportunities and threats analysis is a device that helps business managers to evaluate the strengths, weaknesses, opportunities and threats involved in any business enterprise (Omani, 2011). A SWOT analysis can help them gain insights into the past and think of possible solutions to existing or potential problems, either for an existing business or for a new venture (USDA, 2008). According to Singh (2010), the method of SWOT analysis is to take the information from an environmental analysis

and separate it into internal (strengths and weaknesses) and external issues (opportunities and threats). Nepal is an agricultural country and its contribution to National Gross Domestic Product GDP) including forestry sector is 28.89% (AITC, 2018). The average landholding of Nepalese people is limited to 0.68 ha per household (CBS, 2011; Atreya and Manandhar, 2016). According to Shahi (2016), varying agro-ecological zone of Nepal allow to grow different types of fruits and vegetables. Nabi and his coworkers (2017) indicated that, precision agriculture is designed to optimize agricultural production through the application of crop information system, advanced technologies on production, and improved crop management practices. Precision and protected horticulture are the tools of modern agriculture and more precisely, protected horticulture comes under precision horticulture (Atreya et. al., 2019). Precision agriculture as precision farming, precision horticulture, Site Specific Farming (SSF), Site Specific Management (SSM), Site Specific Crop Management (SSCM), Variable Rate Application (VRA) (Nabi et.al., 2017). Various types of protected structure suitable for specific types of crops and agro climatic condition have emerged with the advancement in agriculture technology (MoAFW, 2018), among them green house, plastic house, lath house, cloth house, net house, shade house, hot beds and cold frames are use in Nepal (IDSC, 2009). Its aim is to minimize environmental impact at increasing productivity with low cost (Maheswari et. al., 2008). It provides better way of production than open field (Montero et.al., 2011). Out of estimated 1000 ha protected farming, 70% area falls under vegetable and 30% area under fruits and flower production in Nepal (Atreya et. al., 2019). Population of Nepal is increasing day by day with limited productive land and production. Due to rapid growth of population and urbanization, its urgent need to develop and adopt new production technology. This situation force for producing more with intensifying production system in a sustainable way. Precision and protected horticulture contributes greatly to food and nutrition security by maximizing more and high-quality production per unit of land.

Materials And Methods

Mainly secondary information from different publication and market hub information were the main sources of information for this paper. In this paper, we tried to collect information from main three-horticulture market hubs (Kathmandu, Pokhara and Chitwan) based on production and market concentration. Secondary data collected through different sources were used and descriptive analysis was done based on the available information.

DISCUSSION

Concept of precision and protected horticulture

In precision and protected horticulture; Information, technology, and management are combined into a production system that can increase productivity, improve product quality, allow more efficient use of chemicals, conserve energy, and provide for soil and ground water protection.

I. Information

Information like crop characteristics (different growth stages, water and nutrient requirement, crop health, insect pest incidence), soil characters (physical and chemical properties, color, texture, nutrient status, salinity and toxicity, soil temperature), microclimatic data (daily, weekly, monthly, seasonal), agro-metrological information (canopy temperature, wind direction, speed, humidity, solar radiation and light intensity, light composition), irrigation

and drainage facilities, water availability and other planning inputs of interest according to farm are major information needed for precision farming.

II. Technology

It incorporates Global Positioning System (GPS), Geographical Information System (GIS), Yield monitors (Crop yield measuring devices installed on harvesting equipment), Variable Rate Technology (VRT), remote sensing etc. are some of technology widely used in precision farming.

III. Management (decision support system)

- Use of information technology and different tools like robotics, sensors, control system, GPS, drones, VRT, autonomous vehicles, GPS based soil sampling, automated hardware and software are the key component of farm management.
- Identification of crop growth stages, environmental condition and insect/ pest population in the field for better crop production.
- Choose suitable sensors and supporting technology to record data on these stages and processes.
- Collect, simplify, store and communicate the field recorded data.
- Process and manipulate the data into useful information and knowledge.
- Present the information and knowledge in a form that can be interpreted to make decisions and for profitable crop production choose a suitable action.

Some technologies use in precision and protected horticulture in Nepal

- Greenhouse monitoring system.
- Farm Management System (Vegetable Crops Development Center, Khumaltar).
- Mobile apps for technology dissemination on fruits, vegetables and flowers production.
- Sensor based temperature and RH management by the use of mobile apps for greenhouses (VCDC, Khumaltar).
- Quality sapling production of citrus fruits species under screen house at Warm Temperate Horticulture Center, Kirtipur.
- Germplasm collection and conservation of citrus fruit species under glasshouse (WTHC, Kirtipur).
- Tissue culture lab and screen houses in government farm and private sector for pre-basic potato seed and banana sapling production.
- Soilless farming support grant (hydro and aeroponics).
- Vegetable (tomato, capsicum, cucumber) and flower production under structures (roses, gerbera, carnation).
- Vegetable seedling and flower seedling production using hi-tech structures.
- Use of drones for spraying micro-nutrients and pesticides.
- Apps controlled hydroponics system (water flow, light and temperature control).

SWOT analysis of Precision and Protected Horticulture

Strengths

1. Various policies of the Government are in place to promote the horticulture sector in Nepal (NAP, ADS, ABPP, MPHD).
2. Government support (Presently, PMAMP project started the construction of different structure of green house for precision and protected vegetable cultivation in different district through pocket, block, zone and super zone program).
3. Vegetable farming near to market hubs are profitable and better employment opportunities.

4. Less uses of agro-chemicals, environmentally friendly.
5. Better insect, pests and disease control and less use of pesticides.
6. Proper plant growth irrespective of season and climate.
7. Less risk from natural calamities like hailstone, wind and rainfall.
8. Higher yield per unit time and area, recorded increase in yield up to 5 to 8 times.
9. Undulating terrains, saline, waterlogged, sandy & hilly lands can also be brought under cultivation under protected farming.
10. Suitable for water scarce area, it saves water up to 50% as compare to open field condition.
11. Kathmandu, Pokhara, Chitwan and other growing cities are the largest market hub for fruits, vegetables and cut flowers.
12. Offseason production and efficient use of scarce resources.
13. Building linkage of REE and Institutes like NARC, IAAS, AFU, PU, CTEVT are suitable for research and human resource development.
14. Agriculture Ministry of different provinces: started to promote the protected cultivation of vegetables and cut flowers
15. Positive attitude and keenness of farmers towards vegetable and flower production

Weakness

1. Unavailability of expert (skilled manpower) and quality materials used in green house.
2. Blanket approach for structure design and construction (Terai, Mid hills and High hills).
3. Lack of high yielding and suitable varieties for protected farming, poor quality of seeds and fertilizer.
4. Less risk bearing ability of farmers and less knowledge on protected cultivation.
5. Not all crops are profitable under controlled condition.
6. Needs advanced technology, technical manpower and continuous support for production.
7. Traditional cultivation practices followed under protected structure.
8. Higher initial investments and maintenance cost.
9. Small land holding of farmers and heterogeneity of cropping system.
10. Subsistence farming system.
11. Technological gaps among research, education and extension (REE) organization and at farmers level.
12. Market infrastructure, storage, transportation, credit support etc. are weak.
13. Less research focus on precision and protected horticulture.
14. Continuous cropping injury.
15. Lack of appropriate tools and machinery.
16. Greenhouse structure cost initially looks unaffordable, farmers with zero risk affordability do not come forward to adopt it.
17. Most of the youths in rural areas are not attracted towards agriculture.

Opportunity

1. Off season and year-round production of vegetables to get better return to growers.
2. Shifting from subsistence to commercial vegetable production.
3. Adverse climate can be overcome by different systems of protected production.
4. Production of high quality and healthy seedlings of fruits and vegetables for transplanting in open field supporting early crop.
5. Vertical farming possible through the use of technologies like hydroponics, aeroponics and use of vertical beds for production.
6. Controlled environmental conditions for early raising of nurseries, off-season production of vegetables.
7. Adoption of protected cultivation in urban and peri-urban areas.
8. Transformations of conventional vegetable farming to organic.

9. Provincial headquarter, densely populated and tourist hub centers: demand for year-round safe and quality produce.
10. Large population of educated youth is unemployed; they can be motivated and trained in the field of protected cultivation.

Threats

1. Fluctuation in market price may affect the sustainability.
2. Lack of insurance or limited insurance coverage.
3. Difficulties to encourage small and medium income group farmers in hi-tech greenhouses, due to high initial cost.
4. Environmental pollutions (plastics and metals).
5. High operational cost (electricity and manpower).
6. The entire developmental pattern of protected cultivation is subsidy driven.
7. Continuous monocropping.
8. Absence of standard postharvest management practices.

Sustainability and future Needs

Current technologies	Sustainability and future Needs
1. Naturally ventilated plastic house - Better than available other structures for the mid-hills' regions of Nepal. - Problem in temperature and RH management, Height adjustment according to altitude. Variation in price and quality of materials.	- Modification of structures based on altitude and other climatic parameters is needed. - Proper temperature and humidity maintenance with the use of fertigation and mulching needed.
2. Net house - Thermal net/double layer, use of poor-quality net, durability and quality issues	- Need to develop cheap and location specific technology. - Need more study and research on impact of net house on offseason cultivation. - Quality parameters should be considered.
3. Rain shelter/plastic house/tunnel - Use of silpaulin plastic as roof covering, size of house ranges from (5×12) m2 and (5×20) m2 based on topography, Ignorance on factors like wind velocity , altitude, relative humidity and temperature. - Faulty design and lack of proper crop planning. - No use of pest exclusion net. - Less durable/dependent on bamboo quality. - Location specific height and ventilation mechanism not considered.	- Modification on structures based on altitude and micro climatic condition. - Careful consideration while using covering material as plastic is needed (better to use 100-200-micron plastic for better light intensity and UV stabilization). - Use of ventilated poly house in mid hills and lower hill condition and dome structure in high hill, Temperature and RH controlled system, use of mulching and fertigation facility for better yield is needed. - Mandatory use of pest exclusion net for avoiding whitefly, aphids and Tuta damage.

4. GI Pipe tunnel - Use of MS pipe so iron rusting problem after 1-2 years, Lack of proper ventilation system and height maintenance is not considered. - Ignorance on technical parts like light intensity, wind direction, RH and temperature maintenance.	- Height adjustment according to altitude, and climatic parameters. - Proper attention on ventilation, mulching and irrigation system is needed. - Insect exclusion net with temperature and humidity control is necessary.
5. High-tech plastic house - Use of fan and pad system for cooling and heating system, costly technology, high energy consuming, difficulties in operation.	- Need to develop low cost technology eg sensor-based irrigation management and use of alternative energy for system operation
6. Policy and program level intervention **A. Policy level initiatives:** - National Agriculture Policy (2004 AD)- increasing production and productivity of agricultural crops. Agribusiness Promotion Policy (2006 AD)- Business support activities and market linkage development. Floriculture Promotion Policy (2011 AD)- Public private partnership, production and marketing support.	- Need separate precision and protected horticulture research and development unit under Ministry of Agriculture and Livestock Development (MoALD). - Need clear policy regarding costume duty simplification, liquid fertilizer import, high yielding variety registration in fast track manner and proven technology import. - Strong monitoring and evaluation mechanism for material quality harmonization.
- Agriculture Development Strategy (2015-2035 A.D.)-"A self-reliant, sustainable, competitive, and inclusive agricultural sector that drives economic growth and contributes to improved livelihoods and food and nutrition security." - Fourteenth plan (2016/17-2018/19 AD): competitive and self-reliant agriculture sector, increase agriculture production and productivity (value chain approach- pre to postproduction, output based incentive and youth focused program). **B. Program level interventions** • Youth focused vegetable farming program focusing on bamboo tunnel and open field condition was implemented under the leadership of the then VDD from 2011/12 to 2013/14.	- Establishment of structure manufacturing units /upgrading of present units which saves time as well as money. - Focus on skilled manpower development under research, education, and extension system for proper technology generation and dissemination. - Revision of present course curricula on agriculture by the current agricultural institutions like TU, AFU, PU, CTEVT and etc. - Develop some horticulture farm center as center of excellence on protected cultivation for technology development, training and extension. - Soft loan/zero interest subsidy based on initial investment for youth and progressive farmers and agri-entrepreneurs.

• The then MoAD developed guidelines for hi-tech-greenhouse grant program in 2014/15 AD. • The then VDD has implemented hi-tech seedling production program in Kathmandu and Bhaktapur in 2015/16 AD. • The Then Fruit Development Directorate (FDD) has launched hi-tech fruit sapling production program focusing on olive sapling production in 2016/17 AD. • The then Vegetable development directorate has implemented precision and protected horticulture program for supporting construction of plastic house, GI plastic house, naturally ventilated greenhouse, net house and hi-tech greenhouse for offseason vegetable production in the year 2016/17 AD. It has provisioned grant support for the abovementioned five structures based on per square meter costing and this program has discontinued from year 2018 AD. • Prime Minister Agriculture Modernization Project (PMAMP) in its zone and super-zone area has constructed different protected structures since its first year of implementation from 2016 AD. • From the year 2018 AD seven provincial governments are operating precision and protected horticulture programs as well as commercial farming programs in their respective command areas. • Organic mission programs implemented by federal and provincial government has also given due emphasis on promotion of protected vegetable cultivation. • The Nepal government has strategic aim of doubling farmers' income within five years period for this horticulture including vegetable, flowers and fruit is the most potential sector.	- Output based subsidy on marketable products and market linkages. - Support for postharvest activities (pre-cooling, packaging, labeling, transportation and marketing).

CONCLUSION

Precision and protected horticulture are the tools of modern agriculture system designed to maximize production and productivity of crops using advanced information technology along with various management practices and the momentum of adoption is gaining pace in Nepal also. Increasing pressure on natural resources, population growth, decreasing land holdings, climate change, and its impact on agricultural production system forced to shift towards modern technologies of crop production. Greenhouse monitoring system, farm management system, use of mobile apps, sensor-based temperature and RH management, screen house, glasshouse, tissue culture technology, soilless farming are some of the technical interventions in precision and protected horticulture in Nepalese context. Area and technology specific policy and program level interventions for profitable farming is the present need. Based on the information and SWOT analysis, the identified strategies and future needs play a vital role in farming system development and food security. Nepal government has initiated some programs and support to the farmers; however, farmers are unable to utilize the expected benefit due to poor technological development, and fragile market condition. Emphasis on proper technology development, input supply mechanism and proper market network development are important interventions for the growth of precision and protection horticulture in Nepal.

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