Current Status of Research on Vegetable Seed, Varietal Development, and Future Perspectives in Nepal

Ranjana Rawal[1]*, Amar Bahadur Pun Magar[1] and Tika Ram Chapagain[1]
[1]National Horticulture Research Centre, Khumaltar, Lalitpur

*Corresponding Author: ranjanarawal.narc@gmail.com

Abstract

The horticultural sector in Nepal significantly contributes to the national economy, food security, and rural livelihoods. It has been notable progress in vegetable seed research and varietal development during last decade. The National Horticulture Research Centre including other horticultural research stations have been involved in the varietal research and development. The current breeder and foundation seed production of major vegetable crops under NARC is about 1,900 kg (2080/81). The breeding programs are focused on the development of hybrid and stress-tolerant varieties. Currently, the NHRC has been doing hybridization of tomato, chili pepper and cucumber, and has identified promising pipeline tomato and cucumber hybrids having disease resistance, high yield, and climate resilience traits. Introduction of superior exotic germplasms with the collaboration of international organizations and exploitation of elite local landraces are the important strategies for the varietal development of vegetable crops in the future. Moreover, the prioritized areas of horticultural research include demand-driven varietal development, strengthening source seed production, and conserving local landraces. The strategic directions aim to reduce dependence on imported seeds, promote sustainable vegetable production, and address climate challenges. Overall, Nepal's vegetable seed research and varietal development efforts are pivotal in ensuring food security, improving farmer incomes, and fostering resilient agricultural systems capable of adapting to evolving environmental conditions.

Key Words: Horticulture, Hybrid varieties, Open-pollinated varieties, Seed research

Introduction

Horticultural crops play a significant role in Nepal's agricultural economy, contributing substantially to the livelihoods of farmers, enhancing food security, and providing essential nutrition. The diversity of Nepal's agroecological zones allows for the cultivation of a wide variety of horticultural crops, ranging from temperate vegetables to tropical spices and medicinal plants. The contribution of the agricultural sector to the gross domestic product (GDP) was approximately 24.12% (MoALD, 2023), while the contribution of the vegetable subsector was 5.99% (MoALD, 2022).

Realizing the importance of vegetable sector in Nepal, research studies on vegetable seed and varietal development of major vegetable species have been carried out for last few decades. National Horticulture Research Center (NHRC) carries out problem-based research, develops modern technologies, and transfers them to the farmers. Moreover, germplasm collection and conservation, varietal introduction, varietal development, source seed, and mother stock production, and hybrid breeding, and postharvest management in horticulture crops are some major thrust areas of research in the NHRC. NHRC is also responsible for planning, developing, and releasing/registering improved varieties of vegetables, fruits, spices, and other horticultural crops according to the National Seed Vision, 2015. NHRC has released and registered some varieties of vegetable crops during recent years (NHRC, 2021). NARC is steadily advancing its efforts in seed research as part of its broader mandate to generate demand-driven technologies for vegetable crop production. The Centre has been also focusing on the varietal development, seed quality enhancement, and the adaptability of vegetable crops to diverse agro-ecological zones.

Methodology

This paper provides a concise comprehensive overview of vegetable crop research conducted within the NARC's research stations over the past two to three years. The information in this research paper has been included from a variety of published scientific literatures, NARC station's annual reports, and technical papers. The report highlights key research achievements on the varietal development and release and breeder and foundation seed production.

Results and Discussion

1. Existing Stations and Centers for horticulture research and seed production under NARC

Among the 63 research Stations established by the Nepal Agricultural Research Council (NARC) across Nepal's diverse agro-ecological zones, 19 research stations are devoted exclusively to horticulture. There is NARC's strategic commitment to advancing horticultural science, particularly in the field of vegetable research. These stations are instrumental not only in developing improved technologies on horticultural crops including varietal development and seed research.

Vegetable seed research in Nepal has become a focused area of NARC's that high-quality of improved varieties of vegetable species are crucial for enhancing productivity, reducing dependency on imports, and supporting food security. The major research programs at the NARC's horticultural stations include varietal development, testing, multiplication, and dissemination of superior varieties. The horticultural research carried out in different Stations and Centre includes national centers, provincial directorates, and commodity programs. The research emphasis is given on the development of appropriate agro-technologies based on the farmers' needs and problems, development of disease-resistant, high-yielding, and climate-resilient vegetable varieties.

2. Annual Vegetable Breeder and Foundation Seed Production by NARC Research Stations

In the fiscal year 2080/81, a total of **1,896.35 kg of vegetable seeds,** comprising **188.92 kg of breeder seed** and **1,707.43 kg of foundation seed** was produced by different NARC's Research Stations nationwide. The crops that the source seeds are being grown, are comprised of cauliflower, tomato, broad leaf mustard, radish, French bean, cowpea, turnip, cucumber, okra, brinjal, spinach, garden pea, carrot, Swiss chard, sweet pepper, onion, and lablab bean. The objective of the source seed production from the NARC is to support to the Private Seed Companies for the quality seed production.

Table 1: Status of Source Seed Production by NARC Research Stations in 2080/81

S.N.	Crop	Station	Breeder seed (kg)	Foundation seed (kg)	Total (kg)
1	Cauliflower				
	i. Kathmandu Local	NHRC, Khumaltar	0.7		0.7
		DoAR, Lumle		1.05	1.05
	ii. Khumal Jyapu-1	NHRC, Khumaltar	2.8	14	16.8
		ARS, Pakhribas		2.3	2.3
	Sub Total		3.5	17.35	20.85
2	Tomato				
	i. Srijana Parent Line	NHRC, Khumaltar	0.3		0.3
	ii. Khumal Golbheda Hybrid-2, Parent line	NHRC, Khumaltar	0.015		0.015
	iii. Khumal Golbheda Hybrid-3, Parent line	NHRC, Khumaltar	0.015		0.015
	iv. Pusa Ruby	DoAR, Khajura		1	1
		DoAR, Parwanipur		0.5	
	Sub Total		0.33	1.5	1.33
3	Broad Leaf Mustard				
	i. Khumal Ratopat	NHRC, Khumaltar	1		1
	ii. Khumal Chaudapat	NHRC, Khumaltar	1		1
		DoAR, Parwanipur		0.55	0.55
		HRS, Dailekh	3.75	65.01	68.76
	iii. Manakamana Rayo	HRS, Malepatan	1	20	21
		DoAR, Lumle		1	1
	iv. Marpha Chaudapat	HRS, Jumla	0.5	41.5	42
		DoAR, Lumle		2	
	v. Tangkhuwa Rayo	ARS, Pakhribas		10.3	10.3
	vi. Belachapi Chaudapat	ARS, Belachapi	10		10
	vii. Red Giant	DoAR, Lumle		0.7	0.7
	Sub Total		17.25	141.06	156.31
4	Radish				
	i. Mino Early	NHRC, Khumaltar	1		1

S.N.	Crop	Station	Breeder seed (kg)	Foundation seed (kg)	Total (kg)
		ARS, Pakhribas		88	88
		DoAR, Lumle		6	6
		HRS, Dailekh	3	54.82	57.82
	ii. 40 Days				
	HRS, Malepatan	1	20	21	
		DOAR, Tarahara		11	11
		DoAR, Khajura		0.5	0.5
		NHRC, Khumaltar	0.34		0.34
		DoAR, Lumle		6	6
		HRS, Dailekh	1		1
	iii. Pyuthane Rato	NHRC, Khumaltar	0.5		0.5
		DoAR, Lumle		1	1
	iv. Pusa Chetki	DoAR, Parwanipur		1	1
	v. Tokinashi	HRS, Jumla	0.5	9.5	10
	vi. Lumle Red	DoAR, Lumle		2	2
	vii. Sakurijima	DoAR, Lumle		0.7	0.7
	Sub Total		7.34	200.52	207.86
5	Bean				
	i. Trishuli	HRS, Malepatan	2	10	12
		ARS, Pakhribas		173	173
		NHRC, Khumaltar	24		24
		HRS, Dailekh	9	16.7	25.7
	ii. Four Season	HRS, Malepatan	5	40	45
		HRS, Dailekh	18.7	45	63.7
		NHRC, Khumaltar	8		8
	iii. Semi Light Long	NHRC, Khumaltar	8.8		8.8
	iv. Long Green Bean	NHRC, Khumaltar	6		6
	Sub Total		81.5	284.7	366.2
6	Cowpea				
	i. Khumal Tane	NHRC, Khumaltar	3		3
	ii. Meter Long	DOAR, Tarahara		13	13
	iii. Sarlahi Tane	DOAR, Tarahara		29	29
	iv. Great Wall-2	NHRC, Khumaltar	1.4		1.4
	v. Great Wall-3	NHRC, Khumaltar	1.6		1.6
	vi. Prakash				
	vii. Surya				
	viii. Malepatan-1	HRS, Malepatan	10	300	310
		DOAR, Tarahara		2	2
	Sub total		16	344	360
7	Turnip				
	i. Kathmandu Red	NHRC, Khumaltar	5		5
	Sub total		5		5
8	Cucumber				
	i. Bhaktapur Local	NHRC, Khumaltar	4.6		4.6
		DoAR, Lumle		2.6	2.6
	Sub Total		4.6	2.6	7.2
9	Okra				
	Parwani Kranti	DoAR, Parwanipur		4	4
	Arka Anamika	HRS, Malepatan	5	50	55
		DoAR, Khajura		7	7

S.N.	Crop	Station	Breeder seed (kg)	Foundation seed (kg)	Total (kg)
	iii. Parvati	HRS, Malepatan	5	50	55
		DOAR, Tarahara		18	18
		DoAR, Parwanipur		3	3
	Sub Total		10	132	142
10	Brinjal				
	Pusa Purple Long	DoAR, Khajura		2	2
	PS-1	DoAR, Parwanipur		15	15
	iii. Pokhara Lurkee-1	HRS, Malepatan		3	3
	Sub Total			20	20
11	Spinach				
	i. All Green	HRS, Malepatan	5	50	55
	Sub Total		5	50	55
12	Garden Pea				
	i. Sikkime Local				
	ARS, Pakhribas		26	26	
		DoAR, Lumle		11	11
		HRS, Dailekh	15.5	63	78.5
	ii. Arkel				
	ARS, Pakhribas		32	32	
		DoAR, Khajura		29	29
		HRS, Jumla	5	100	105
		HRS, Dailekh	7.4	90	97.4
	Sub Total		27.9	351	378.9
13	Cress				
	i. Chamsur Sthaniya	ARS, Pakhribas		13.5	13.5
	Sub Total			13.5	13.5
14	Broccoli				
	i. Green Sprouting	ARS, Pakhribas		17.2	17.2
	Sub Total			17.2	17.2
15	Carrot				
	i. New Kuroda	HRS, Jumla	0.5	25.5	26
	Sub Total		0.5	25.5	26
16	Swiss Chard				
	i. Susag	HRS, Jumla	0.5	17	17.5
	Sub Total		0.5	17	17.5
17	Sweet pepper				
	i. California Wonder	DoAR, Khajura		2	2
	Sub Total			2	2
18	Onion				
	1.1 Red Creole				
	HRS, Jumla	0.5	4.5	5	
		HRS, Dailekh	3	86.5	89.5
	Sub Total		3.5	91	94.5
19	Lablab bean				
	Malepatan Hiunde Simi-1	HRS, Malepatan	3		3
	Malepatan Hiunde Simi-2	HRS, Malepatan	3		3
	Sub Total		6		6
	Total		188.92	1707.43	1896.35

Table 2: F1 tomato hybrid seed production by Private Sectors in 2078/79

F1 tomato hybrid seed production by private sector and farms in 2078/079

S. N.	Name of organization	Inbred seed provided (g)	Estimate Hybrid seed produced (kg)
1.	Anmol Seeds Pvt.Ltd	20	3.5
2.	Kathmandu Agro Concern, Lalitpur	55	6
3.	CEAPRED, Lalitpur	28	30
4.	Sarba Shrestha Seed Pvt. Ltd. Bhaktapur	35	45
5.	Himalayan Seeds Research &TrainingCenter, Dolakha	20	13
6.	Raina Seed International, Kathmandu	13	10
7.	Pramila Krishi Farm, Kathmandu	13	10
8.	Gorkha Seed Pvt. Ltd. Kathmandu	70	42
9.	Dibya Seed Pvt. Ltd. Kathmandu	5	0
10.	Namuna pryabarniya krishi farm, Dang	50	9
11.	Sivasakti Agro& Seed center Pvt. Ltd. Lalitpur	7	3
12	SEAN Seeds and Service Centre	3	27
13	Bimal agro farm and research cenrtre, Bharatpur	11	5
14	Crimpson Integrated Farm, Godawari	7	2.5
15	Nirjala Seeds and Agro Pvt.Ltd	7	2
16	Barahi Mauri tatha Ghaar Nirman Udhyog, bajrabarahi	3	0.5
17	Urja Agro Pvt.Ltd	6	4
18.	Vegetable Crop Development Centre, Lalitpur	21	12
19.	Vegetable Seed Production Centre, Rukum	8	3
20.	Horticulture Development Resource Centre, Malepatan	5	0.4
21.	Spices Crop Development Center,Panchkaha	10	1
22.	Horticulture Research Station,Malepatan	7	0.2
23.	Horticulture Research Station, Dailekh	4	0.5
	Total	408	229.6

3. Varietal Improvement in Vegetable Crops

NARC has significant achievements on the varietal development of vegetable crops. As of now, , a total of **281 varieties** have been released and or registered. Of the total, **94 are open-pollinated (OP) and 187 are hybrids**. The **National Horticulture Research Centre (NHRC)** has played a pivotal role on the varietal development including hybrids. Notably, the Centre has recently released two tomato hybrids: namely **Khumal Golbhenda Hybrid-2** and **Khumal Golbhenda Hybrid-3.** in order to meet the diverse needs of growers and the market. In **2080/81,** five varieties: **Pokhara Lurki-1**, a variety of brinjal developed by the **Horticulture Research Station (HRS), Malepatan**, **Kalo Bhanji** and **Jimpakha Rayo**, broad leaf mustard varieties, **Tistung Akbare, a chili variety,** and **Madale Kakro,** a variety of cucumber have been registered. The inclusion of farmer-developed varieties reflects a growing emphasis on the local adaptation and more resilient varieties in the climate change context.

4. Registered/released varieties during 2021 to 2024

Cucumber

- **Madhu F1**: A hybrid variety known for its attractive appearance and superior taste. It exhibits a vigorous branching habit with multiple branches. The first fruit sets at around **58 days after transplanting.** Fruits weigh approximately **550–565 g.**, with an average yield of **70–75 tons per hectare**. The predominant fruit skin color is **white** and it is recommended for cultivation in the **mid-hill regions** (600–1600 m asl). The variety was released by NHRC in 2022.
- **Krishna F1**: This hybrid cucumber also features attractive color and excellent taste. It has a similar branching

habit as of Madhu and sets fruit **55 days after transplanting.** Average fruit weight ranges from **530 to 535 g,** with an yield **of 60–65 tons per hectare. The fruit skin is green and it is suited for the eastern hill regions (600 -1600 masl).** The variety was also released by NHRC in 2022.

Tomato

- **Khumal Golbhenda Hybrid-2**: An indeterminate hybrid tomato, has average fruit weigh **70–80 g**. It yields **60 - 70 tons per ha**, with first harvest at **70 days in mid-hills** and **80 days in the Terai.** It is **tolerant to late blight** and produces red fruits. The variety is recommended for **mid-hills and Terai, and it** was released by NHRC in 2021.
- **Khumal Golbhenda Hybrid-3**: This hybrid is also an indeterminate type, having average yield of **60 - 65 tons per ha**, with an average fruit weight of **70-75 g**. First harvest occurs at **65 days (mid-hills)** and **75 days (Terai).** It is **late maturity, blight tolerant,** with **red-colored fruits** andrecommended for the **Terai and mid-hills.** The variety was also released by NHRC in 2021.

Onion

- **Khumal Pyaj-1**: Yield **40–45 t/ha**, with green leaves 40–45 cm long and **10.2 mm wide.** Bulb weigh **160–180 g** and are **light yellow** in color. The variety was registered by NHRC in 2024.
- **Khumal Pyaj-2**: Yield **35–40 t/ha**, with green leaves 37–40 cm long and **8–9 mm wide.** Bulb weight **120–130 g**, with a **dark violet** color. The variety was registered by NHRC in 2022.

Lablab Bean

- **Malepatan Hiudesimi-1**: Light green pods, sowing time: **Asar–Shrawan**, first picking at **140-150 days after sowing**, with a yield of **25-30 t/ha** and recommended for **300-1250 m asl**. The variety was registered by HRS, Malepatan in 2022.
- **Malepatan Hiudesimi-2**: Pod color: light violet, first harvest at **135-145 days after sowing,** yield: **15-20 t/ha,** and recommended for **300-1250 m asl**. The variety was registered by HRS, Malepatan in 2022.

Broad Leaf Mustard

- **Manakamana Rayo**: It is ideal for planting between **Asoj-Kartik in 800–1600 m asl.** The variety was registered by HRS, Malepatan in 2021.
- **Belachapi Chaudapat:** Features **soft leaves** and **late bolting**, recommended for the **Terai and inner Terai** regions. The variety was registered by ARS, Belachapi in 2024.

Garlic

- **Rajikot Lasun-1:** An open-pollinated variety with a **maturity period of 250-260 days** and a yield of **17.26 t/ha,** suitable altitude for **2000–3000 m asl** in **Karnali Province.** The variety was registered by HRS, Rajikot in 2024.
- **Rajikot Lasun-2:** Matures in **230-240 days**, with a higher yield of **21.8 t/ha,** recommended for the same elevation range. The variety was registered by HRS, Rajikot in 2024.

Brinjal

- **Pokhara Lurki-1**: Fruit yield 25-30 t/ha with **15–26 cm** fruit length. First picking at **70–75 DAT.** The variety was registered by HRS, Malepatan in 2024.
- **Parwanipur Selection:** Grows to a height of **65-75 cm**, has a **crop duration of 170-180 days**, and yield of **25-26 t/ha**. The variety was registered by DoAR, Parwanipur in 2021.

French Bean

- **Chaumase Simi:** This variety begins pod picking at **55–60 DAS, with yield of 18-20 t/ha**. It is well-suited for cultivation in the **Terai, mid-hill, and high hill regions** up to an elevation of **2200 m asl.** The variety was registered by NHRC in 2022.

5. Promising/Pipeline Varieties

The NHRC in collaboration of Horticultural Research Stations and Directorate of Agricultural Research has made significant progress in developing promising varieties of vegetable crops. The evaluation and verification of promising cultivars of various vegetable species are underway. These pipeline varieties are as following:

Table 3: Promising genotypes of vegetable crops

S.N.	Crop	Variety	Characteristics	Recommended Domain	Office
1	Cauliflower	Terai-1	Harvesting period 63 DAS, average curd weight 248 g, relatively heat tolerant, and yield 20.89 t/ha	Mid-hills	NHRC
2	Cauliflower	Terai-2	Harvesting period 58 DAS, average curd weight 193 g, relatively heat tolerant, and yield 14.67 t/ha	Mid-hills	NHRC
3	Taro	HRMCOL001	Corm diameter: 17.2 cm, corm weight: 1.5-3.5 kg, and yield: 40-50 t/ha	Terai and mid-hills	HRS, Malepatan
4	Radish	HRDRAD002 (Okura)	Mid-season variety, short and thick white root, serrated green leaves, and yield 63.20 t/ha	Terai and mid-hills	NHRC
5	Radish	HRDRAD005 (Miyasige)	Mid-season variety, oblong thick and white root with green top, serrated green leaves, and yield 63.90 t/ha	Terai and mid-hills	NHRC
6	Tomato	AVTO 0301	Indeterminate, late blight resistant, oval fruits (45-50 g), and yield: 45-50 t/ha	Terai, inner Terai, mid-hills	NHRC
7	Tomato	AVTO 1705	Semi-determinate, oval fruits (50-60 g), and yield 35-40 t/ha	Terai and inner Terai	NHRC
8	Potato	CIP 392025.7	Suitable for chips, late blight tolerant, and yield 20-28 t/ha	Terai, mid, and high hills	NPRP, Khumaltar
9	Capsicum	HRDCAP001	Determinate, fruit weight 69.9 g, yellow fruit color, and 37.8 t/ha	Mid-hills	NHRC
10	Pea	HRSDGP11-13	Flowering within 58 DAS, green pod yield 12.9 t/ha, seed yield 1.30 t/ha, powdery mildew tolerant	Mid-hills	HRS, Dailekh

6. Progress in the development of hybrids and stress-tolerant varieties at NHRC

The **NHRC, Khumaltar** has been focused on the hybrid development including biotic and abiotic stresses tolerant varieties of major vegetables. It has been significant progress in **tomato hybrid development**. Currently, multi-location evaluation of **35 F1 single-cross tomato hybrids has been underway for last three years.** The precious traits including bacterial wilt and late blight resistant, fruit characteristics and yield of exotic germplasms are considered for developing hybrids. Most of the genotypes introduced from **the World Vegetable Centre, Taiwan have been included in the hybridization. From these F1 hybrids, some promising hybrids have been screened and are kept in pipeline for the release in coming season.**

Besides tomato hybrid development, hybridization programs in cucumber, **bitter gourd, sweet pepper, and brinjal have been progressed in NHRC.** Currently, evaluation of the developed F1 hybrids for their specific traits under different agro-climates are going on in collaboration with NARC Horticultural and Provincial Directorates. Likewise, screening of tomato genotypes against two diseases: late blight and bacterial wilt have been conducted for last six years in NHRC. Among the lines, **AVTO 1915** and **AVTO 1705** were identified as resistant to late blight, while **AVTO 1314, AVTO 1718**, and **AVTO 9802** showed moderate resistance. For bacterial wilt, **AVTO 0301** demonstrated strong resistance, and both **AVTO 0301** and **AVTO 1718** were found moderately resistant. Notably, **AVTO 1718** showed dual tolerance to both diseases, making it a valuable genetic resource for developing resilient tomato hybrids.

Moreover, NHRC has introduced several genotypes of tomato, sweet pepper, brinjal, bitter gourd, and cucumber from international research institutions, with a strategic focus on enhancing crop resilience to various biotic and abiotic stresses. These genotypes have been specifically evaluating for their **tolerance to biological challenges** including various **diseases, heat stress, drought,** and **soil** factors.

7. Future Strategies to Strengthen Vegetable Research

Prioritize Demand-Driven Varietal Development*:* NARC should focus on the varietal development, addressing the farmers' needs, market demand, and climate challenges. Incorporating participatory breeding approaches will

ensure greater relevance, adoption, and impact of research outputs.

Strengthen Breeder Seed Production and Maintenance Breeding*:* Enhance the capacity of NARC's Stations to produce and maintain high-quality nucleus and breeder seeds of the released and or registered varieties.

Enhance Research Infrastructure and Human Resources*:* Invest in modern research infrastructure, laboratories, and equipment, particularly for seed physiology, biotechnology, and genetic analysis, including capacity-building programs for the human resources.

Promote Conservation and Use of Indigenous Genetic Resources*:* Priority should be given on the collection, conservation, and utilization of indigenous landraces and varieties, which are crucial for developing climate-resilient and high-yielding varieties.

Expand Public-Private and Institutional Partnerships*:* NARC should collaborate research programs with universities, private seed companies, NGOs, and international organizations to leverage resources, access global germplasm, and develop varieties of consumer's preference and market trend.

Coordination with Extension and Seed Production Agencies*:* Foster coordination among NARC, DoA, NCPVC, and Private Seed Campanies and Cooperatives to ensure wide delivery of improved varieties and seeds through national seed systems, and feedback from the stakeholders.

Enhance Data Management and Research Planning Systems*:* Develop a central seed research database and monitoring system to track breeding progress, varietal performance, and their dissemination.

Conclusion

Nepal's horticultural sector, particularly vegetable seed research and varietal development, has made significant achievements during last decade. NHRC and other NARC's Stations have released and registered open-pollinated as well as hybrids of major vegetables, which are high yield potential including disease resistant. Further efforts on the hybrid development, stress tolerance, and disease resistance have been continued with the objectives of enhancing productivity, climate resilience, and farmer's livelihoods. For future strategies to cope up the future challenges of climate changes and farmer's demand, there must focus on demand-driven breeding, conserving indigenous genetic resources, and fostering hybrids development.

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