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.

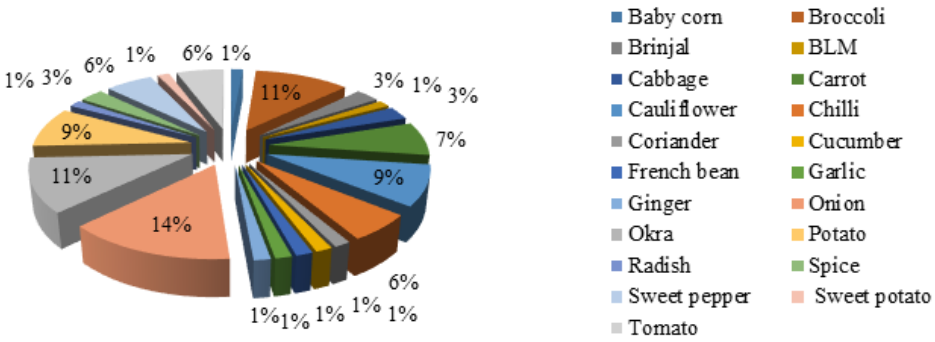

Figure 1. Major vegetable species in which research conducted at Agricultural Colleges/Universities of Nepal

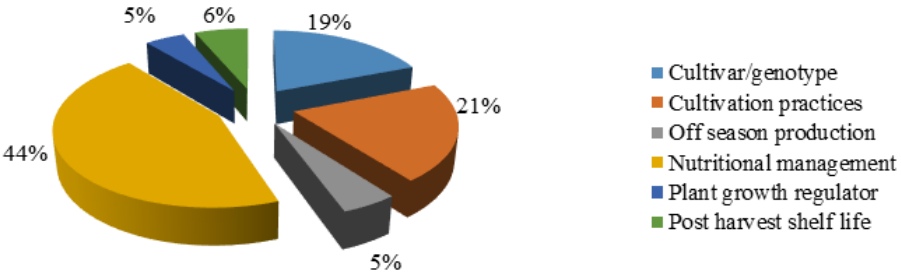

Figure 2. Aspects in which research on vegetable species conducted at Agricultural Colleges/Universities of Nepal

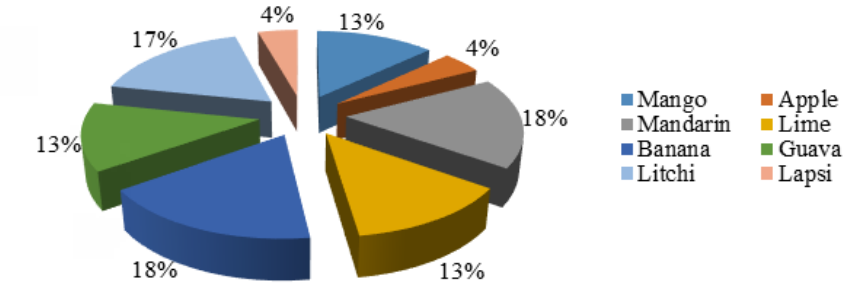

Fig 3. Major fruit species in which research conducted at Agricultural Colleges / Universities of Nepal

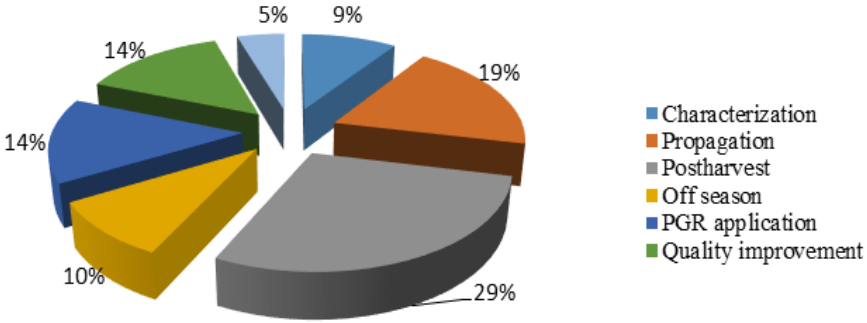

Fig 4. Aspects in which research on fruit species conducted at Agricultural Colleges/Universities of Nepal

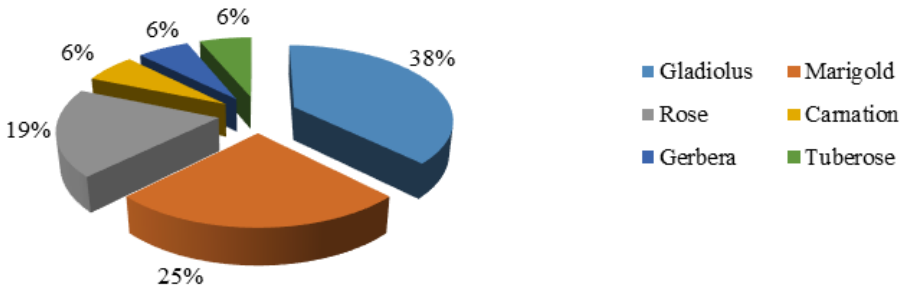

Fig 5. Major ornamental species in which research conducted at Agricultural Colleges/Universities of Nepal

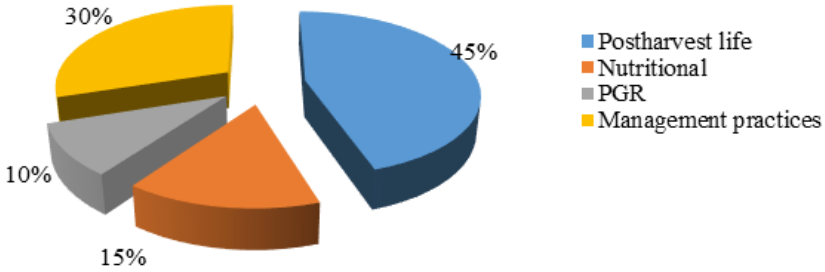

Fig 6. Aspects in which research on ornamental species conducted at Agricultural Colleges/Universities of Nepal

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.

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