



## Need to take precedence for off seasonal vegetable farming? Issues in context of Nepal

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### ABSTRACT

Vegetable farming beyond the regular cropping calendar when supply is low and prices are high increases consumers range of choices and enhance profit. Nepal offers favourable potential for off-season vegetable production. However, inadequate approach to market and seasonal fluctuation of available vegetable creates difficulties in commercialization of off-season production. The current paper describes about what opportunities and importance do off-season farming has in Nepal and the constraints it has to encounter with. The cheap availability of labour, increasing interest of the government, and climatic suitability provide an opportunity for the farmers to make profitable income due to high prices during the off-season period which reduces the risk of failure of the farm, marketing risk, and maintains market equilibrium. Nevertheless, this cultivation system faces challenges of high post-harvest loss, poor implementation of policies, hijacked subsidies, inadequate irrigation facilities, and high pest infestation on-farm side and scarcity of cold storage, high transact cost, unmanaged collection, and market centers on the market side. Commercialization of off-Season vegetable production can create a better environment for income improvement and maintain market equilibrium.

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## Introduction

The vegetable is the leading sub-sector contributing 80.09% of the total national horticulture production and sharing about 9.7% of the total agriculture gross domestic product of Nepal (CASA, 2020). With the expansion of awareness and health consciousness, through different electronic and paper media, the demand for fresh and healthy vegetables has increased significantly in the past few years. Nepal's overall per capita vegetable consumption has increased from 60 kg to 128.04 kg over the last two decades (OWD, 2021). Vegetables have a higher commercialization rate (30-50%) (Bhimisen et al., 2016) and high cost-benefit ratio 1:3 than that of cereals (1:1.5) (CASA, 2020). Thus they can be effectively commercialized. The production of vegetables in another season rather than their main season either by altering the sowing period, use of hybrid and photo-insensitive varieties, or by cultivation under a protected environment is called off-seasonal farming. The off-seasonal vegetable production area of Nepal is scattered from east to west throughout the country in most of the road-accessible areas and areas near the market (USAID, 2011). A report from USAID, Nepal showed that off-seasonal vegetable

production and marketing is very famous among the farmers and the marketers due to the high price in that period (USAID, 2011).

A wide range of agro-ecological variation and spatial climatic conditions creates a comparative advantage for the commercial production of different vegetable crops like cauliflower, cabbage, tomato, brinjal, and more than two hundred vegetable species and their varieties in Nepal (Shrestha et al., 2004). The production of off-season vegetables, utilizing these spatial climatic variations and ecological niches, could be extremely beneficial in the context of nutrition, employment, and income generation (USAID, 2011). The government of Nepal is also emphasizing the production of off-season vegetables in the potential pocket areas of Nepal by providing subsidies, tools, and machinery at reasonable prices to develop off-season vegetables as an important cash crop that could enhance the income level of farmers and thus help reduce the incidence of poverty and prevent food insecurity in the country (APP, 1995).

Tomato, radish, cauliflower, brinjal, summer squash, cucumber, onion, carrot, chilli, and swiss chard are the

major off-season vegetables grown in Nepal (Ranabhat and Khadka, 2019). Due to the higher return per unit of land, better response to fertilizers input compared to others crops like fruits and cereals, the production of vegetables is increasing day by day. Off-season vegetable has contributed to the economic upliftment of many economically poor farmers in the hills of Nepal by providing regular employment and by better utilization of marginal land (Panta, 2001). The main objective of the study is to find out the importance, challenges and recommend possible strategies to cope with the challenges for the healthy production of off-season vegetables in Nepal. Also, the major techniques for producing off-season vegetables are described which will certainly help make policies and plans in the future for better evaluation of the off-season vegetable cultivation situation in Nepal.

### Methodology

The study is based on both primary and secondary sources of data. For primary source of data, field visit was made to farmer’s farm and Kalimati wholesale market on May 3, 2021 Kathmandu district of Federal Republic of Nepal. Key information interview (KII) was selected as a method to collect primary source of data. Secondary data were collected from journal articles, newspapers, websites, web profiles of the Ministry of Agriculture Development (MOAD), Ministry of Agriculture and Livestock Development (MOALD), Food and Agriculture Organization (FAO), USAID Nepal, Commercial Agriculture for Smallholders and Agribusiness Programme (CASA), and other governmental and non-governmental organizations. The data was analysed using Ms. Excel and descriptive statistics were used during the study.

### Results and Discussion

#### Production status of off-season vegetables in Nepal

Total vegetable production in Nepal in the Year 2018/19 was 4,271,270 metric tons with a productivity of 14.37 Mt/ha (MOALD, 2020). This is 7.9% more than the vegetables produced in the year 2017/18 (MOALD, 2020). Vegetable production has increased by 23.69% in last ten years (MOALD, 2020) with an annual rate of average 5% which is quite more than the annual average population growth of Nepal 1.83% (Statista, 2020). The rapid trend of urbanization, increasing economic conditions, the concentration of population in city areas, increasing health awareness led to a rapid rise in demand for fresh and healthy vegetables in the Nepalese market. To meet the demand, production increased from 2,754,406 metric tonnes in 2008/9 to 3,580,085 metric tonnes in 2014/15 and is still increasing and have reached 4,271,270 metric tonnes in the year 2018/19 (MOALD, 2020). The area for vegetable production also increased significantly from 225,154 hectares in 2008/2009 to 297,195 hectares in the year 2018/19 which is 31.99% more than the year 2008/9 (MOALD, 2020).

Among all the cultivated off-season vegetables, tomato, cauliflower, cabbage cultivation is considered as most profitable (USAID, 2011). It is estimated that 3,243,521 households are involved in vegetable production in Nepal (USAID, 2011). The majority are from Kavre, Dhading, Bhaktapur, Lalitpur, Makwanpur, Kathmandu, Nuwakot, Sindhupalchowk, Gorkha, Dolakha, and Rasuwa districts (MOAD, 2014). Among the seven provinces of Nepal, Gandaki province has the better potentiality of producing off-season vegetables due to better road connectivity and market hubs offering higher chances for value chain integration and export of vegetables to other provinces (CASA, 2020). The production status of different off-season vegetables is shown in Figure 1 (MOALD, 2020).

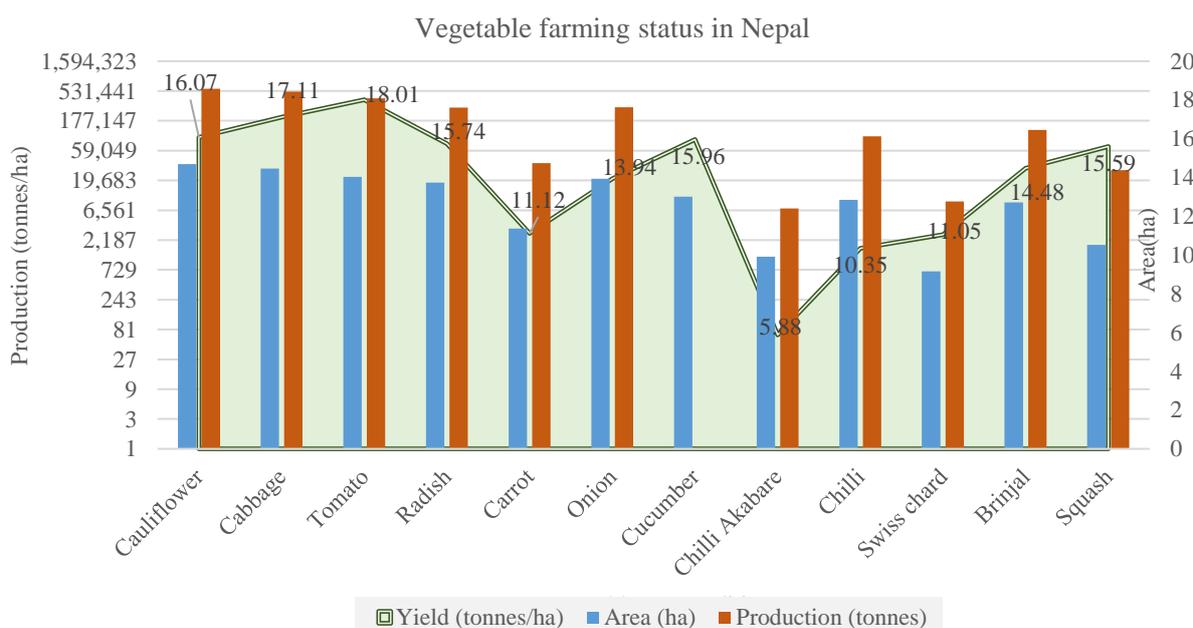


Figure 1. Production Status of Major off-season vegetables in Nepal

### Vegetable consumption per capita: 1961-2017

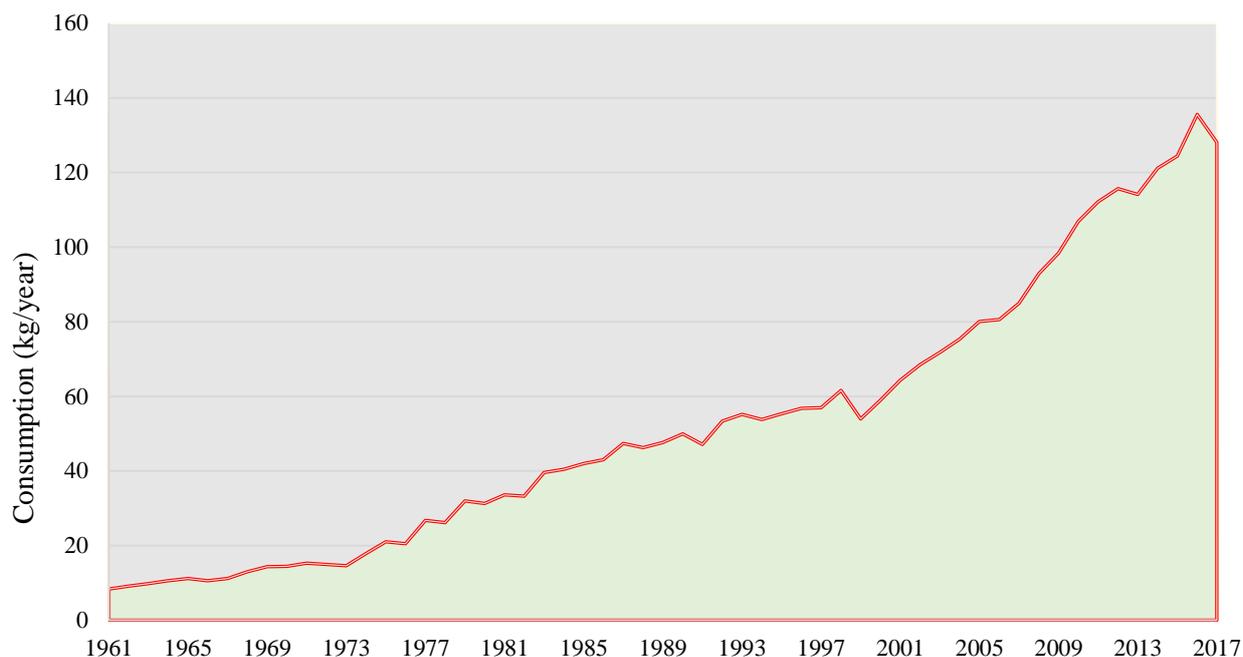


Figure 2. Average per capita vegetable consumption of Nepal from 1961 to 2017, measured in kilograms per person per year.

Table 1. Nutrient Content in Vegetables

Vegetables Serving Size (gram weight/ ounce weight)	Calories (Kcal)	Sodium (mg)	Potassium (mg)	Dietary Fibre (g)	Protein (g)
Asparagus 5 spears (93 g/3.3 oz)	20	0	230	2	2
Bell Pepper 1 medium (148 g/5.3 oz)	25	40	220	2	1
Broccoli 1 medium stalk (148 g/5.3 oz)	45	80	460	3	4
Carrot 1 carrot, 7" long, 1 1/4" diameter (78 g/2.8 oz)	30	60	250	2	1
Cauliflower 1/6 medium head (99 g/3.5 oz)	25	30	270	2	2
Cucumber 1/3 medium (99 g/3.5 oz)	10	0	140	1	1
Green Cabbage 1/12 medium head (84 g/3.0 oz)	25	20	190	2	1
Green Onion 1/4 cup chopped (25 g/0.9 oz)	10	10	70	1	0
Onion 1 medium (148 g/5.3 oz)	45	5	190	3	1
Potato 1 medium (148 g/5.3 oz)	110	0	620	2	3
Radishes 7 radishes (85 g/3.0 oz)	10	55	190	1	0
Summer Squash 1/2 medium (98 g/3.5 oz)	20	0	260	2	1
Sweet Potato 1 medium, 5" long, 2" diameter (130 g/4.6 oz)	100	70	440	4	2
Tomato 1 medium (148 g/5.3 oz)	25	20	340	1	1

Vegetables Serving Size (gram weight/ ounce weight)	Iron (%DV)	Vitamin A (%DV)	Vitamin C (%DV)	Calcium (%DV)
Asparagus 5 spears (93 g/3.3 oz)	2	10	15	2
Bell Pepper 1 medium (148 g/5.3 oz)	4	4	190	2
Broccoli 1 medium stalk (148 g/5.3 oz)	6	6	220	6
Carrot 1 carrot, 7" long, 1 1/4" diameter (78 g/2.8 oz)	2	110	10	2
Cauliflower 1/6 medium head (99 g/3.5 oz)	2	0	100	2
Cucumber 1/3 medium (99 g/3.5 oz)	2	4	10	2
Green Cabbage 1/12 medium head (84 g/3.0 oz)	2	0	70	4
Green Onion 1/4 cup chopped (25 g/0.9 oz)	2	2	8	2
Onion 1 medium (148 g/5.3 oz)	4	0	20	4
Potato 1 medium (148 g/5.3 oz)	6	0	45	2
Radishes 7 radishes (85 g/3.0 oz)	2	0	30	2
Summer Squash 1/2 medium (98 g/3.5 oz)	2	6	30	2
Sweet Potato 1 medium, 5" long, 2" diameter (130 g/4.6 oz)	4	120	30	4
Tomato 1 medium (148 g/5.3 oz)	4	20	40	1

Percent Daily Values (%DV) are based on a 2,000-calorie diet

### Consumption pattern of vegetables in Nepal

The consumption pattern of vegetables has also significantly increased in Nepal (Figure 2) (OWD, 2021). The per capita consumption of vegetables has increased from 8.34 kg in 1961 to 128.04 kg in 2017 (MOF, 2016). Vegetables are a good source of minerals and vitamins. They supply adequate amount of dietary fiber, vitamins, minerals and surplus number of phytochemicals that function as antioxidants, phytoestrogens, and anti-inflammatory agents (Slavin and Lloyd, 2012). Fiber intake prevents the formation of cardiovascular disease and obesity (Slavin and Lloyd, 2012). Among other provinces of Nepal, Bagmati province ranks at the higher position in terms of vegetable consumption followed by Lumbini province (CASA, 2020). Mainly city areas popular for tourism consume more amount of vegetables. Cities like Pokhara, Kathmandu, Dharan consume more vegetables than any other city in Nepal due to the higher number of hotels, restaurants, and higher concentration of population.

Furthermore, Cabbage has been reported to be rich in vitamin C, protect radiation therapy, prevent cancer, promote the health of the heart and improve the immune system (Ware, 2017). Tomatoes have been reported to prevent constipation, promote eye health, prevents prostate cancer (Smith, 2020). Spinach has been reported to lower blood pressure, broccoli promotes the health of the bladder, liver, breast, and stomach, peas protect against oxidative stress and cancer, sweet potatoes regulate blood sugar, beets prevents diabetic neuropathy and carrot promotes eye health (Smith, 2020). All these health benefits are luring people for increasing the consumption pattern of vegetables. Different vegetables contain a variable amount

of nutrients as shown in Table 1 which are essentially necessary for human growth and development (FAD, 2021).

### Techniques of off-season vegetable farming

Cabbage, cauliflower, capsicum, tomato, brinjal, cucumber, summer squash, watermelon, bitter gourds, green peas, swiss chard, leafy vegetables, turnip, pointed gourds, okra, radish, carrot, potato, chilli, garlic, and onion are popular off-season vegetables grown in Nepal (Deshmukh et al., 2019). Figure 3 shows different techniques of producing off-season vegetables.

Off-season vegetables can be grown by two methods; Natural method and protected cultivation (Deshmukh et al., 2019). The natural method indicated cultivation of off-vegetables by using hybrid or photo-insensitive varieties by adjusting planting or sowing time, river-bed cultivation, and protected cultivation means cultivation of vegetables inside the artificially controlled environment. Protected cultivation includes poly house, lath house, green poly house, hotbeds, row cover, plastic tunnel, cold frames, and net house. The common method of off-season vegetable production in Nepal is protected cultivation and some farmers also practice the natural method of crop production. Among protected farming, plastic tunnel and greenhouse are much popular. The plastic tunnel can be easily prepared by locally available resources like bamboo, and plastic used in the plastic tunnel is quite cheap than the glass used in the preparation of greenhouse and lath house. Simple and low-cost protected technology like plastic low tunnels, walk-in tunnels, are often used for off-season vegetable cultivation in Nepal (Jayasurya et al., 2021).

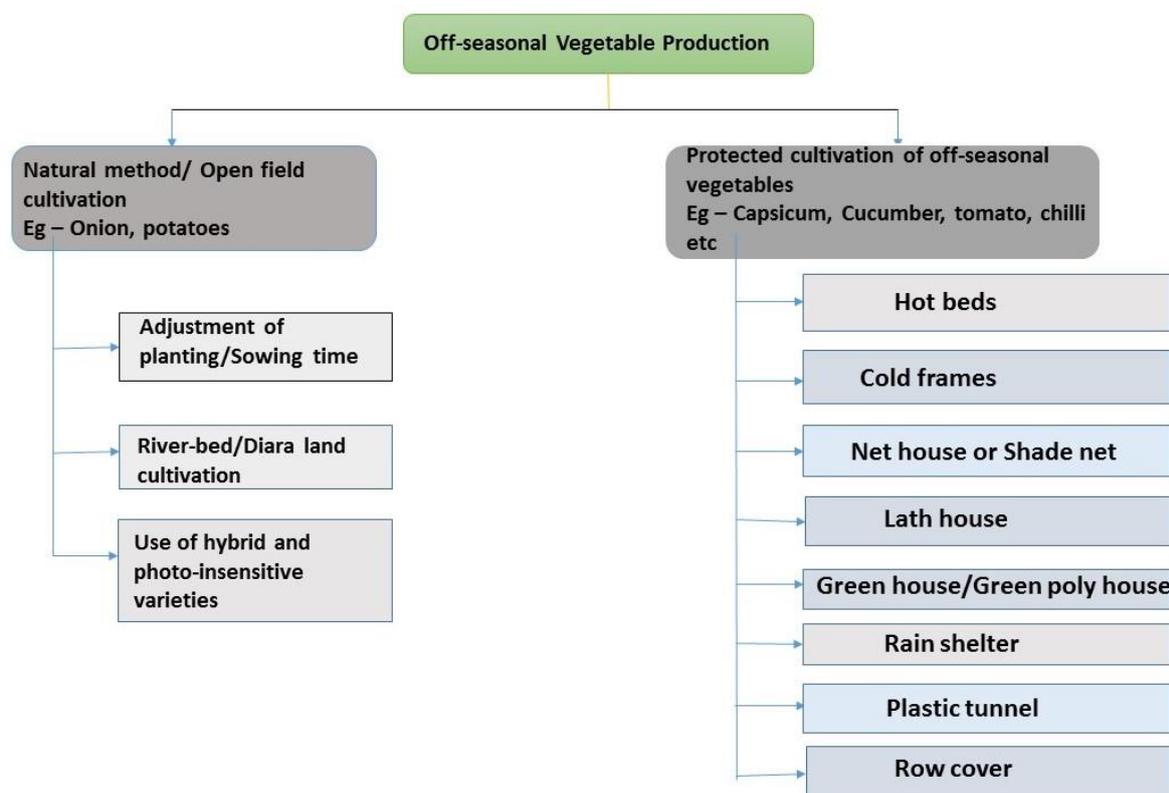


Figure 3. Techniques of off-season vegetable production in Nepal



Figure 4. Production of off-season tomato in a plastic tunnel

#### ***Growing of summer vegetables in the winter season***

The demand for summer vegetables such as tomato, brinjal, okra, bitter gourd, bottle gourd, cucumber, pumpkin, summer squash which are grown during June-July-August in open field conditions, now is gaining importance due to their health and nutritional importance in diet which forced them to grow under winter conditions (Sahu, 2020). Winter vegetables can be grown in the summer season under controlled environmental conditions in a protected cultivation system. These include poly house, greenhouse, lath house, plastic tunnel, row cover, etc (Figure 4) (Gyawali, May 3, 2021). Among protected farming, the ventilated poly house is found to be more appropriate for growing cucumber all-round year with better yield as well as with better ascorbic acid concentration (Phookan and Barua, 2016). Sweet pepper, parthenocarpic crossover hybrid brinjal can be grown effectively under-ventilated poly house conditions (Sahu, 2020). Tomatoes produce better fruit quality, color, and texture when grown under the naturally ventilated poly house and when grown under net house produce better yield with reduced pest damage (Cheema et al., 2004). It has been found that row cover can increase the fruit yield of many cucurbitaceae vegetables like summer squash, cucumber, and melon up to 25% (Sahu, 2020). Yield of capsicum was found to increase by 2.34 times more than that in open field (Ghosal and Das, 2012).

#### ***Growing of winter vegetables in the summer season***

Winter vegetables such as cabbage, cauliflower, broccoli, carrot, radish, turnip can be grown during summer by using a shade net or shade house (Figure 5) (Gyawali, May 5, 2021). A shade house is a protected structure that provides a miniature atmosphere condition for optimum growth and development of vegetables. It is generally enclosed by shade nets or some other woven material to maintain required daylight, dampness, and air to go through the holes and create suitable environmental conditions inside the shade net. Shade net has been reported to increase the yield of a pea up to 285%,

capsicum by 70%, and tomato by 58.66% (Sahu, 2020). Insect-proof nets houses or shade nets can be effectively used to reduce insect attacks on vegetables which can probably minimize the use of pesticides in off-season vegetable cultivation and for the production of virus-free seeding (Jayasurya et al., 2021).

#### ***Growing of winter vegetables in the rainy season***

High soil moisture, heavy downpour increases the infestation of more disease, pests, and pathogens which created a problem for growing vegetables during the rainy season (MOAD, 2016). Bacterial disease winter vegetables such as cabbage, cauliflower, French beans, spinach can be successively grown in the rainy season by adopting rain shelters and polytunnels (Sahu, 2020). Rain shelters protect the crop from direct rainfall and protected the soil from being waterlogged and conditions of high moisture content.

#### ***Pocket areas of off-season vegetables***

Some of the major collection and production pocket areas have been identified which are known for their ability to produce off-season vegetables at a higher comparative advantage than other places in Nepal (Table 2) (USAID, 2011). 6 districts are considered as pocket areas for off-season vegetables namely; Surkhet, Dailekh, Salyan, Palpa, Dhankuta, and Ilam. These production areas have good production potential, good road connectivity, and better market access.

#### ***Opportunities of off-season vegetable farming*** **High price**

Generally, vegetables grown during the off-season get paid well (Table 3) (Kalimati wholesale market, 2020/21). During the off-season, the production of vegetables is generally low but the demand is high. When the production does not meet the demand, the price automatically rises and becomes maximum during the year. Thus, producing vegetables during this period can be very much beneficial for the farmers.



Figure 5. Production of off-seasonal tomato in net house

Table 2. Major off-seasonal vegetable production and collection centre

Districts	Pocket areas
Surkhet	Harre, Gaddi Chaur
Dailekh	Seri Goganpani, Piladi, Jore banch, Dharam Pokhara
Salyan	Dhaniwang, Grarta, Rim, Chinwang, Thalwang, Tribeni, Siddeshwari, Chhayachhetra
Palpa	Madanpokhara/Nayapati, Dumre, Aaryabhanjyang, Bhairabsthan
Dhankuta	Parewadin, Murtidhunga, Hattikharka, Tankhuwa, Bhirgaun, Belahara, Pakhribash, Bhedetar
Illam	Fikkal, Pashupatinagar, Illam municipality, Sumbek, Shoyang, Shakhejung, Kolbung, Godak, Panchakanya, Chulachuli, Sangrumba

Table 3. Price of major vegetables during the season and off-season period.

Commodity	Price at on season /kg (in \$.)	Price at off-season/ kg (in \$.)
Tomato	0.25-0.30	0.70-0.80
Cabbage	0.20-0.25	0.40-0.50
Radish	0.10-0.15	0.50-0.55
Brinjal	0.15-0.20	0.40-0.50
Cucumber	0.10-0.15	0.40-0.60
Pea(Green)	0.40-0.50	0.90-1
Leafy vegetables	0.10-0.15	0.25-0.30
Onion	0.30-0.40	0.80-0.90
Garlic	0.50-0.60	1.0-1.50
Broccoli	0.60-0.70	1.0-1.10
Cauliflower	0.20-0.25	1.10-1.20
Chilli (Green)	1.0-1.5	2.0-2.2
Bitter guard	0.20-0.25	0.80-0.90
Squash	0.10-0.15	0.25-0.3
Capsicum	0.30-0.40	0.7-0.8

#### ***The increasing interest of government***

Recently, the government has been showing interest in vegetable farming. Prime minister agriculture development project emphasizes the production of vegetables in identified pocket areas all around the nation by providing subsidies, tools, and pieces of equipment at reliable prices (MOF, 2016). Further, Agriculture knowledge centers have been established for effective extension services. Off-seasonal vegetable cultivation has been made easy at the local level by providing plastic tunnel, drip irrigation, and technical help through experts affiliated with the Agriculture knowledge center. Further, CBOs, NGOs,

cooperatives are supporting farmers for off-season vegetable cultivation by providing cost-free training at the local level.

#### ***Marketing***

Increasing demand for off-season vegetables can be a merit point for farmers to deal with the marketing problem. In the scarcity of vegetables during the off-season period, traders would collect all the available products from the farm. Thus, farmers would not have to worry about marketing their products.

### ***Climatic suitability***

The spatial climatic condition and ecological niches in the hills of Nepal are suitable for the production of off-season vegetables with better quality, taste, and texture. There is a good opportunity to produce tomatoes, cauliflower, cabbage, bitter melon of better texture and taste in hills than in the terai region of Nepal. Demands of vegetables in the terai region in the summer season can be fulfilled by supplying from hilly regions. Winter vegetables such as cole crops, radish, potato, and so on can be grown in hilly regions during the summer season and those vegetables can be supplied to the terai region and India.

### ***Availability of inputs***

Many private extension service providers have opened their branches at the local level. These service providers like private agro-vets provide better quality hybrid seeds, pesticides, insecticides, and fertilizers necessary for vegetable production. Further, they also provide tunnel plastic, tools, and machinery, technical help for construction of standard poly house/greenhouse, and timely inspection of the field.

### **Constraints**

#### ***On the Production/farmer's side***

Off-seasonal cultivation of vegetables requires a modern greenhouse, poly house, and or other protected cultivation system which is economically expensive to farmers. One of the biggest obstacles for producing off-seasonal vegetables in Nepal is the lack of access to capital to support their growth. Banks charge high interest which can not be afforded by farmers in Nepal. Furthermore, governmental funding are limited to registered farms and agro industries. Rural farmers are always deprived from funding provided by government.

#### ***Higher pest and disease infestation***

Growing vegetables other than their main season can lead to an increased infestation of diseases and pests. To protect the crop, a farmer must apply a large number of costly pesticides. A study carried out in Bangladesh showed that, even when income from off-seasonal vegetable farming increased by 48%, the pesticide uses also increased by 56% (Schreinemachers et al., 2016). The plant protection directorial revealed that 89% of total pesticide consumed in Nepal is used for vegetable production and the remaining 11% for other crops (PPD, 2014). Farmworkers and their family members are on great exposure to agricultural pesticides. Long exposure can cause serious health hazards like mild skin irritation, tumor, nervous disorder, endocrine disruption, and even death (Lorenz, 2009).

#### ***Poor implementation of policies and hijacked subsidy***

Even though the government brings out different support plans and policies, they are confined within the paperwork and if implemented, only a few farmers of accessible areas are benefited. Every year, the government allocates a considerable amount of funds as subsidies for the farmers but the fund vanishes between government officials and farmers. Even after the 4 years of implementation of the Prime Minister Agriculture

Modernization Project (PMAMP) and 6 years of implementation of agriculture development strategy (ADS), Nepal has not been able to be self-reliant on vegetables. This has led to an import of fresh vegetables worth around Rs 14 billion within the six months fiscal year 2020/21 (MOF, 2020).

### ***High post-harvest losses***

Vegetables are highly perishable and need utmost care to avoid post-harvest losses. Farmers do not foresee any need to adopt post-harvest skills which results in a significant increase in post-harvest losses. A study revealed that post-harvest losses of vegetables can reach up to 33% and among other vegetables, tomato suffers the highest post-harvest loss (CASA, 2020). The post-harvest losses of vegetables in a developing country are assumed to be 20-50% (Tiwari et al., 2004). The post-harvest losses of off-seasonal vegetables in Nepal are 25-50% mainly due to improper handling and poor facilities at the collection centre (USAID, 2011). Insufficient knowledge about the post-harvest technique, packaging, and transportation miss handle are major causes for post-harvest losses in off-season vegetables.

### ***Lack of irrigation***

Nepalese agriculture system is mainly rain-fed type and depends upon monsoon rain for production of majority agricultural commodity. Only 1.80 million ha of land has the accessibility of irrigation and, out of which 1.40 million ha lies on the Terai, or plains (ADB, 2010). Lack of irrigation is one of the major constraints for off-seasonal vegetable production during the summer season mainly in the hilly region of Nepal.

### **Requires Specific Skills**

Production of off-seasonal vegetables requires specific skills and knowledge.

A crop needs optimum temperature, an adequate amount of water, humidity, and nutrients for better growth and development. In a protected cultivation system, all these parameters should be carefully maintained and regulated throughout the growth period. Many farmers of Nepal are illiterate and this concept is new to them. Every vegetable commodity has different ecological and edaphological requirements. So, this can be a big challenge in the commercialization of off-seasonal vegetables.

### ***On Market Side***

Most of the vegetable markets in Nepal are unorganized. They lack cold storage facilities to store fresh vegetables. There are 35 cold storage all around the country and can store 3000 metric tonnes of stock (Gyawali and Khanal, 2021). The production of vegetables in Nepal in the year 2018/19 was 4,271,270 metric tons (MOALD, 2020). If we calculate around 0.07% of vegetables can only be stored if all the cold stores are used. The remaining 99.93% of vegetables produced need immediate sell otherwise they start rotting in the market.

### ***High transaction fee and long route***

Nepal completely depends upon the roadways for transportation. Transportation of goods through roadways

takes a long time and is expensive. It is always a challenge to keep vegetables fresh for a long time until they reach the market for sale. Higher transportation cost while supplying vegetables from hilly region to terai region increases the price of the off-season vegetables.

#### ***Unmanaged collection center***

Collection centers are often unmanaged and workers do not have enough skills to reduce post-harvest losses during marketing and shipping of vegetables. It has been reported that more than 30% of post-harvest loss occurs while shipping the vegetables from the producers' farm to wholesalers, the losses have been found to have increased by 50% as the products move to consumers (CASA, 2020).

#### ***Lack of road connectivity to hilly districts***

Even though road facilities have been widening throughout the nation, some of the hilly and mountain districts still lack proper road connectivity. Roads are often blocked by continuous landslides mainly in hilly districts. This creates a problem for the marketing and shipping of vegetables.

#### **Strategies for overcoming challenges**

The government through its organization must seek to develop plans and policies to encourage farmers to produce vegetables during the off-season period. For this, subsidy policies, crop insurance policies, institutional development, and cooperative policies can be implemented.

#### ***Advertisement***

Commercialization of off-season vegetables is only possible after making farmers know about the economic importance off-season vegetables. For this, advertisement through paper and electronic media can be effective in the case of Nepal.

Simple books, booklets, or posters can be developed and circulated among farmers at different local levels.

#### ***Development of Pocket areas***

There are few pocket areas identified for off-season vegetable production. Commercialization of off-season vegetable farming is only possible after involving the majority of farmers in targeted commodities. For this new pocket, areas should be identified and developed for the commercial production of vegetables.

#### ***Promotion of the use of botanical pesticides***

Chemical pesticides pollute the environment and when used haphazardly, can cause serious health hazards. The use of chemical pesticides should be discouraged or minimized and the use of biological pesticides should be promoted. Biological pesticides such as Neem plant extract, titepati, asuro, latana, and other organic products should be promoted instead of chemical pesticides.

#### ***Development of necessary infrastructure***

Cold stores, road accessibility to production, and collection center are utmost necessary for strengthening the commercialization of off-season vegetable production. Thus, the government through its organization must seek ways to increase the number of cold stores and road accessibility to potential production pocket areas.

#### ***Training activities and widening of extension activities***

The governmental and non-governmental organizations should seek to extend extension activities and provide training related to the identification of varieties, the ecological and edaphological requirement of crops, adequate application of nutrients, controlled use of pesticides, and technique of vegetable production inside the protected system. Regular field inspection should be carried by experts to suggest the proper method and skills of vegetable production.

#### ***Subsidy and technical support***

Subsidies and technical help from experts can be an effective means to motivate farmers by reducing the economic burden for setting up expensive protected environmental conditions for vegetable production. This can make farmers feel that the government is concerned about improving their economic condition and providing help where ever necessary.

#### **Conclusion**

Off-season vegetable farming can be an effective means for dramatically improving the economic condition of rural people in Nepal. This technique of vegetable production is beneficial from an economic and nutrition point of view. It helps in maintaining market equilibrium and ensures the supply of fresh vegetables all around the year. There is a high opportunity for off-season vegetable farming in Nepal because of diverse agro-climatic conditions and ecological niches. Nevertheless, it has to deal with many challenges from both production and marketing aspects for the commercialization of off-season vegetable farming. Higher pest and disease infestation as compared to normal season, the requirement of technical knowledge, poor infrastructures facilities, post-harvest loss, and so on are the major hindrances from the production point of view. Similarly, poor infrastructure facilities and unscientific collection centers are the major challenges from a marketing point of view for the wide adoption of off-season vegetable farming in Nepal. For smooth and effective commercialization of off-season vegetable cultivation, the identified constraints on the both production and marketing side should be addressed by concerned authorities. The government needs to be more flexible about widening the extension activities, and policies implementation. Providing required equipment and training free of cost, the establishment of additional cold stores, and the addition of few more pocket areas are of the utmost importance. Furthermore, provisions of subsidies, technical help, and policies such as insurance can motivate the farmers for the commercialization and wide-scale adoption of off-season vegetable cultivation in Nepal.

#### **Conflict of Interest**

The authors declare that there is no conflict of interest with this publication.

## Author's contribution

Pramod Gyawali designed the study, analysed the data and prepared the manuscript. Sagar Bhandari and Saugat Khanal critically reviewed the manuscript and co-wrote the paper. The final form of manuscript was then approved by all authors.

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