Protected Vegetable Cultivation Technology for Cold Arid Agro-ecosystem of Ladakh

Abstract

Ladakh region is a high altitude cold arid desert with special agro-climatic features. The region is one of the driest and coldest inhabited places on the earth. Due to harsh climatic features, short growing season is unable to offer sufficient food particularly vegetables. To supplement, fresh vegetables have to be imported by truck in summer or flown in by air during winter. The unavailability and high cost means that local people rarely eat fresh vegetables during the winter spell of the year, but instead rely on dried leafy vegetables and only stored root crops and cabbages. Specialized agricultural practices need to be developed and demonstrated for food and nutritional security of the inhabitants of the region. Protected cultivation is a well defined sustainable technology for off season food production and thereby an important component in attaining nutritional security. It offers scope for furthering the technologies to achieve self sufficiency.

Keywords  Agro-ecosystem; Vegetables; Ladakh

Introduction

Ladakh represents a distinct agro-ecosystem of Jammu and Kashmir State of India with unique climatic and geographical features. This cold arid part of the country is characterized by climatic conditions like maximum sunny days in a year, low annual precipitation (80~300 mm) that too mostly in the form of snow extending from late autumn to early spring, when the temperature for the most parts of the day is well below 0º Celsius. There is both diurnal and seasonal fluctuations in temperature ranging from +30º to -30º Celsius and can touch +39º to -60º Celsius in some pockets. Thus wide variations existing in the region result in creation of micro-climatic pockets that also influence the crop range and practices. Due to extreme long winter, the agriculture season is short, which extends from May-September in general, and in case of particular location, it depends upon altitude (Table 1). The soil has a preponderance of sand and gravel resulting in low water holding capacity and poor nutrient status. This in combination with high solar radiations and dry winds further complicates the situation, leading to a unique environmental and geographic situation reflected in the beautiful pastures of Changthang, Zanskar, Suru and Drass Nubra Valleys of the region and sparse plant life in the rest of the area which throws up a display of colour whenever there is a rainfall. It is because of these conditions that in the vastness of this region well hamlet are found close to water sources and only a meager percentage of total geographical area is under cultivation and agriculture occupation of the masses is restricted to few months in a floating. Tourism and developmental activities are creating an increase in the demand for agricultural goods. The challenge is to offer the sector a viable option of livelihood.

Horticultural crops possess the potential to contribute directly and indirectly to the economy and food security of the region. This sector is yet to be exploited to its optimum potential. To achieve this, specialized scientific technological interventions having potential for diversification and sustainable production need to be employed. Plasticulture has revolutionized
Table 1 Altitude, cropping season and cropping duration in Ladakh

| S. No. | Altitude meters (Amsl) | Cropping season       | Duration (Months) |
|-------|------------------------|-----------------------|-------------------|
| 01    | 2400–2700              | Late March to October | 7.0               |
| 02    | 2700–3000              | April to Mid-October  | 6.5               |
| 03    | 3000–3300              | May to September      | 5.0               |
| 04    | 3300–3600              | Mid-May to September  | 4.0               |
| 05    | 3600–4000              | June to August        | 3.0               |

Note: Protected cultivation/greenhouse technology

The production possibilities under adverse conditions. Plasticulure is a system of growing crops using plastic components as tools for addressing adverse growth conditions. The discovery and development of polyethylene polymer in the late 1930s, and its subsequent introduction in the early 1950s in the form of plastic films, mulches, and irrigation tubing, revolutionized the commercial production of several horticultural crops and gave rise to Plasticulure.

Evaluation of farm friendly cultivation technology for the production of high value vegetable crops during summer and sustaining the vegetable production system in the region during the freezing winters can be well achieved by protected cultivation technology (Kanwar and Akbar, 2011).

Protected cultivation practices can be defined as a cropping technique wherein the micro-climate surrounding the plant body is controlled partially/fully as per the requirements of the plant species. Through various techniques, the environment is modified to value it close to normal periods of growth. Protected cultivation is considered as a recent and innovative Plasticulure intervention for the cultivation of high value crops for sustaining the agricultural production and productivity. The ever increasing population pressure on the globe calls to facilitate some precision farming technologies to meet the present food requirements within the same available cultivable land on proper scientific lines in a sustainable manner. It’s potential to answer the problem by providing handsome returns and a multi-fold increase in cropping intensity within the same piece of land as has been revealed in many scientific findings across the globe. With the advancement in agriculture various types of protected cultivation practices suitable for a specific type of agro-climatic zone have been emerged. The cultivation of high value crops under climate-controlled conditions has been found to be more remunerative as it makes product available in a season, when it is not possible in the open.

Greenhouse technology is more than 200 year old and Europeans are considered to be the pioneers in this field. With the advent of plastic during the World War II a new phase in the greenhouse technology emerged. At present nearly 90 per cent of the new greenhouses are being constructed by utilizing ultra violet (UV) stabilized polythene sheets as the glazing material replacing the costly non flexible glaze. In India, the technology is still in its nascent stage. The area under greenhouse cultivation, as reported by the end of 20th century was about 110 hectare in India. This figure is quite significant when compared with the total area under greenhouse in the world which was 275,000 hectare as reported for the year 1999-2000. (Mishra et al., 2010)

In Ladakh region many vegetable valuable crops like Tomato, Binjal, Okra do not perform well in the open conditions and those surviving produce poor yields. Capsicum cultivation during summer season seems a profitable alternative for Ladakhi farmers if the crop is grown under greenhouses as in open field condition, capsicum cultivation is not successful venture (Kanwar and Sharma, 2010). This is because of the high diurnal fluctuations in temperature. In addition, the open cultivation season is very short to meet the demand adequately. Produce from various parts of the country is imported to meet the demands of the population of the region especially during winter months. Besides, The short growing season wild edible plants are also used in dry and fresh form to meet the kitchen requirements (Lamo et al., 2012). Open cultivation during off season (Late autumn to mid spring) winter months is impossible because of the freezing temperature (around −40° Celsius).
Subzero temperature in greenhouse can be avoided by providing adequate thermal storage mass (Wani et al., 2011).

Various types of greenhouses have been tried in the region by various agencies. The cost of production per unit worked out by Singh et al (2008) (Figure 1) showed that double walled polyench had the lowest cost of production.

Various structures for cold arid region have been tested and evaluated for the production of various horticultural crops. In a similar study PFDC, Leh found that the yield from spinach was highest in LEHO -type greenhouse (Kanwar et al., 2011), while that of cabbage in Chinese type greenhouse (Table 2).

The production of high value vegetable crops like coloured capsicum is under investigation. The economic yield of cucurbits can also be achieved under various naturally ventilated structures.

The PFDC since its inception is working to evaluate various structures for the year round vegetable cultivation. Overview of Chinese typt polyhouse, Trench technology and ow tunnels is detailed.

**Chinese Type Polyhouse**
The dimension of Chinese type poly-house is 100×20 feet. This poly-structure is suitable for commercial cultivation in Ladakh region (Figure 2; Figure 3). It is best suits for the production of vegetables during winter months. During winter season, around 20 cuttings of spinach were harvested. Cabbage heads of 800~200 gram are ready from end of February poly-house. Besides high quality capsicum is cultivated in the

| Poly-house Structures | Crop (Variety) | Spinach (Yield/sq.mtr.) | Harvesting period | Cabbage (Yield/sq.mtr.) | Harvesting period |
|-----------------------|---------------|-------------------------|-------------------|-------------------------|-------------------|
| Chinese type          |               | 4.50                    | Dec~April         | 4.60                    | March~April       |
| LEHO type             |               | 4.65                    | Dec~April         | 3.40                    | March~April       |
| Local poly-house      |               | 3.12                    | Jan~April         | –                       | –                 |
| Mud walled            |               | 4.10                    | Dec~April         | 3.20                    | –                 |

Note: PFDC Leh report, 2010-2011

Table 2 Performance of various protected structures in Ladakh during winters

Figure 2 Vegetables during peak winter inside Chinese type polyhouse

Figure 3 Outside view of Chinese summer. Early nursery raising of vegetables and annual flowers can be taken up for commercial purpose. The details of production are presented in the Table 3. A general detail of the production calendar is presented in Table 3.
Table 3 Production calendar of Chinese type polyhouse

| Season          | Vegetables                                      | Duration              |
|-----------------|------------------------------------------------|-----------------------|
| Winter          | Spinach, cabbage, Chinese cabbage, lettuce, kale | 15th Dec to 15th of April |
| Nursery raising | Vegetables and annual flowers                   | 1st April to 1st May  |
| Vegetables      | Coloured capsicum                               | May to November       |

This technology is found useful for the Propagation of apricot nursery it has been found to extend the growth period by almost two months producing stronger whips and providing congenial conditions for grafting and budding.

**Trench Technology**

Trench is one of the oldest & cheap protected cultivation technologies in operation in the cold arid region. A trench unit consists of four underground chambers each of 6 m×4 m×1.5 m. Polythene is installed over it to provide protection to the crops (Figure 4; Figure 5). This structure does not require much skill in its construction and management. Its cost is lower among all the green houses and being an underground structure, heat losses are minimum (Singh and Dhaulakhandi, 1998) strong winds do not affect polythene cover much and hence it is long lasting. This structure is therefore being recommended as most suitable greenhouse for the region (Singh et al., 1998). Early Vegetable nursery can be raised successfully. Details of production technology are presented in Table 4.

Table 4 Production Calendar of Trenches

| Season          | Vegetables                                      | Duration              |
|-----------------|------------------------------------------------|-----------------------|
| Winter          | Spinach                                         | 15th January to 15th of April |
| Nursery raising | Vegetables and annual flowers                   | 1st April to 1st May  |
| Vegetables      | Cucurbits, brinjal, tomatoes                    | June to November      |

**Plastic Low Tunnel Technology**

Plastic low tunnels provide a cheap and better way for off-season cultivation of vegetable production. Low tunnels also offer several advantages like protection of the crop from adverse climate along with crop advancement from 20~20 days over their normal season of cultivation. Healthy and early nursery raising can be obtained under low tunnels. Technology for Summer squash production has been extended to the farming community successfully (Figure 6; Figure 7). Cultivation calendar details are in Table 5.

Figure 4 Cucurbit cultivation inside

Figure 5 Outside view of covered trench

Figure 6 Outside view of low tunnels during summer and winter
Figure 7 Vegetable crop under low

Table 5 Production Calendar of Low Tunnels

| Season        | Vegetables  | Duration          |
|---------------|-------------|-------------------|
| Winter*       | Garlic      | -                 |
| Nursery raising| Vegetables  | 15th April To 15th May |
| Vegetables    | Cucurbits   | July To November  |

Note: *Reported by Mishra et al., 2010

Conclusion

Agricultural Economy of our country cannot be realized meagerly with regional development or a particular geographic section, Agricultural advancement in the region is in the infancy stage and is not yet explored up to its optimum potential. Ladakh region has been labeled as a tough and hectic agro-ecological region by various agencies and researchers. The region demands some unusual agricultural practices to flourish. Horticulture industry has so far depicted a viable figure of India at the global level. A vast hidden potential exists in the high altitude cold deserts of India which if possibly exposed can bring new vistas in the horticulture sector. Protected cultivation is the possible answer to uplift the economic status of the farming families of the region along with meeting the nutritional requirements. Farm friendly low cost technologies adaptive to the marginal farmers need to be evaluated and disposed. Chinese type polyhouse is a new introduction of a protected structure for commercial utilization. Apart from this trenches are a viable option for domestic agriculture/kitchen gardens. Another low cost technology is the low tunnels having enough potential in cold desert Ladakh region of India.

References

Kanwar M.S., and Akbar P.I., 2011, Vegetable Cultivation in Cold Arid Region of Ladakh: Challenges and Opportunities, Rashtriya Krishi, 5(2): 81
Kanwar M.S., Sharma O.C., 2010, Performance of capsicum under protected cultivation in cold arid region, Journal of Hill Agriculture, 1(1):88-89
Kanwar M.S., Saleem M.S., and Akbar P.I., 2011, Effect of Protected Structures on Cabbage Production in Freezing Winters of Ladakh Region, Indian Horticulture Journal, 1(1): 23-25
Lamo K., Akbar P.I., and Mir M.S., 2012, Underexplored and Underutilized Traditional Vegetables of Cold Arid Ladakh Region of India, VEGETOS, 25(1): 271-273
Mishra G.P., Singh N., Kumar H., and Singh S.B., 2010, Protected Cultivation for Food and Nutritional Security at Ladakh, Defense Science Journal, 61(2): 219-225
PFDC Annual Report, 2010-2011, HMAARI, Leh, Ladakh.
Singh N. Singh R., Kumar H., Bhoyar M., and Singh S.B., 2008, Sustainable vegetable research for nutritional security and socio-economic upliftment of tribal's in Indian cold deserts. In, Advances in Agriculture, Environment and Health, edited by S.B. Singh, et al. SSPH Publication, New Delhi.
Singh B., Dhoualakhandi A.B., 1998, Application of solar greenhouse for vegetable production in cold desert. In Renewable energy: Energy efficiency policy and the environment. Elsevier Science Ltd, UK, pp. 2311-314.
Wani K.P., Singh P.K., Narayan N., Khan S.H., and Amin A., 2011, Prospects of vegetable production in cold arid region of Ladakh, Achievement and future strategies, International Journal of Current Research, 33(6): 10-17