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A REVIEW :

Full length review paper on cropping systems for sustainable vegetable production

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SUMMARY : India grows the largest number of vegetables in the world. Varied agro climatic conditions in India make it feasible to grow several vegetables round the year. As many as 61 annuals and 4 perennials are grown in India.Being short duration crops, vegetables are more susceptible to extremities in environment. And vegetable production is also not consistent due to weather extremities and diminishing natural resources. In countries like India it is a serious problem in view of large population depending on agriculture, excessive pressure on natural resources and poor cropping mechanisms. Malnutrition in children in India is also increasing alarmingly. Vegetables play an important role in achieving the nutritional security as they encounter the malnutrition problems in India and also serve as a source of income for the small and marginal farmers.The major objectives of reducing malnutrition and alleviating poverty indeveloping countries through improvedand consumption of safe vegetables that involves adaptation of current vegetable cropping systems like, multiple cropping, mixed farming, intercropping, and relay cropping systems. Integration of crop production, different farming systems with suitable soil and water conservation measures lead to sustainable production increase in income levels and towards better livelihoods. Major emphasis should be given on development of diverse technologies for optimization of farm resources, increased economic return and improved sustainability.

KEY WORDS :
Vegetables, Cropping systems, Multiple cropping

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BACKGROUND AND OBJECTIVES

A significant change in climate on a global scale will impact vegetable cultivation and agriculture as a whole; consequently affect the world's food supply. More erratic rainfall patterns and unpredictable high temperature spells consequently reduce crop productivity. The impact of climate change will hit the developing countries the hardest, and it is in these countries food security will be most threatened.For ensuring a healthy and prosperous nation, we have to increase our production by modifying our cropping pattern and dietetic habitsHorticultural farm is relatively labor and capital intensive undertakings, there by its adoption by the farmer is dependent upon whether or not revenues derived from it could atleast compensate for all cost spent by farmer. Vegetables are an excellent choice of cash crops as they can be grown easily, produce

good yields and generate high price in the market compared to the cereals.Vegetables are generally sensitive to environmental extremes and Environmental stress is the primary cause of crop losses worldwide, reducing average yields for most major crops by more than 50 % (Bhardwaj, 2012).

Moreover, increasing temperatures, reduced irrigation wateravailability, flooding, and salinity will be major limiting factors in sustaining and increasing vegetable productivity. Extreme climatic conditions will also negatively impact soil fertility and increase soil erosion.Measures to adapt to these climate change-induced stresses are critical for sustainable tropical vegetable production. Adoption of suitable cropping system is one such measure which ensures maximum utilisation of natural resources and inputs. Farmers may get benefitted by following different cropping systems even under adverse climatic conditions. Success in mitigating climate change depends on how well agricultural crops and systems adapt to the changes and concomitant environmental stresses of those changes on the current systems.Thus, adoption of suitable cropping patterns/systems will be needed to maintain vegetable productivity.

Cropping system :

Cropping system is defined as a cropping pattern followed on a farm and its interaction with farm resources, other farm enterprises and production technology. In other words cropping system refers to a combination of crops in time and space. When annual crops are considered, a cropping system usually means the combination of crops within a given year (Willey *et al*., 1989). The term cropping system is often used interchangeably with multiple cropping, which in fundamental nature represents an idea of maximum production per unit area of land within a year or some other relevant time unit with minimum land degradation (Singh, 1972). The yearly sequence and spatial arrangement of crops and fallow on a given area is termed as cropping pattern. India has over 17% of world's population living on 2.4% the world'sgeographical area. Capital percapita agricultural land has reduced by 67% from 0.48 hectare in 1951 to 0.12 in 2014 due to explosive increase in the population. A considerable amount of land remains unutilized and such lands are subjected to many degradative processes. Input and other resources applied to unoccupied portion of land go waste. Not only horizontal utilization of land is ensured but also vertical utilization of land is ensured.

Principles for arranging cropping sequence :

– Repetition of crops having common diseases and pests should be avoided

– Vegetable crops of different families grow well after majority of crops. Growing cucurbitaceous vegetables after solanaceous is not profitable

– The deep rooted crops should be followed by shallow rooted ones

– Heavy feeding crops should be followed by low feeding crops

– Specific nutrition requirement of various crops should be taken into consideration

– Leguminous vegetable crops should be included in the cropping sequence which not only upgrade the protein status of the farm produce but also enhance soil fertility

– Green manure crops should be accommodated in the rotation in order to increase the organic matter status of the soil

Benefits of cropping system :

– Maximum utilization of land
– Maximum utilization of inputs
– Better harvest of solar radiation
– Yield continuum
– Regular income
– Sustainable production
– Maintain and enhance soil fertility
– Enhance crop growth
– Minimize spread of disease
– Control weeds
– Inhibit insect and pest growth
– Increase soil cover
– Reduce risk for crop failure
– Use resources more efficiently

Types of vegetable based farming systems :

In order to reduce the impacts of climate change, farmers must follow different vegetable based farming systems like multiple cropping, mixed cropping, intercropping, relay cropping and agro forestry systems.

Multiple cropping :

It consists of growing of two or more crops on the same piece of land. It is intensified cropping system in

which utilization of land in time and space dimensions are ensured. In its simplest form, multiple cropping is a one year cropping system in which two or more crops are grown in succession within a year. Harvesting more number of crops from the same piece of land during a specified period of time is the main focus of multiple cropping. It is influenced by climate, varieties, crop rotation, farmers motivation. Both crops and varieties selected for multiple cropping should be suited to the local climate and soil conditions. Short duration and thermo or photo insensitive varieties are preffered.Shortday onion varieties are not suitable for growing at high altitudes where long day types are adapted. Multiple cropping is labor intensive requiring constant and careful management which may discourage some farmers to adopt it. However increases in production and net profit may motivate the farmers to undertake it.

Strategy for multiple cropping:

– For raising crops, an advanced schedule must be prepared.

– Laboratory tests should be conducted to predict initial fertility status of soil.

– Recommended dose of manure and fertilizers should be applied to each crop.

– Micronutrients should be applied to crops, if needed.

– Legume crops must be included in the system for the fixation of elemental nitrogen.

– Early maturing and high yielding varieties of crops must be selected.

Ex:-Pusa purple long is an extra early variety of brinjal

Pusa sambandh is an early maturing variety of cabbage.

Basic principles of multiple cropping :

– Development of crop varieties and hybrids for specific climatic requirements or duration

– Soil management

– Method of tillage

– Crop residue management

– Judicious use of fertilizer and other chemicals

Kishore *et al*. (2014) studied the sequential vegetable production under protected condition in temperate humid region. Under protected condition tomato-pea-carrot-cucumber gave the maximum production efficiency, returns (Rs. 13336.1/100m²), BCR (4.05) and profitability (36.53/100m²/day) when compared to pea-coriander-french bean-bitter gourd sequence.

Crop rotation :

Crop rotation is the practice of growing crops on a particular piece of land in a systematicsequence in order to maintain the soil fertility. It may also be defined as growing of crops inrecurrent succession on the same piece of land either for a year or for longer period of time. The rotation of crop may be for one year, two year, three or more years. Hence, the cycle of cropping sequence takes more than one year to complete. The crop rotation should be adapted to climate and soil and crops involved may have high market value. In crop rotation non host crops may be included instead of crops of the same botanical family in order to have better protection against diseases and insect pests.

Sequence of crops recommended for crop rotation at IIHR, Banglore for Karnataka region

– Okra-Tomato-French bean

– Tomato-French bean-Okra

– Brinjal-Cauliflower-Chilli

– Cowpea-Cauliflower–Okra

– Okra-Vegetable pea-Onion

Sharma and Kumar (1994) studied effect of crop rotation on population dynamics of *Ralstonia solanacearum* in tomato wilt sick soil and observed that okra-maize-radish, ragi-French bean-okra, maize-carrot-cucumber crop rotation have significantly reduced the primary inoculum of in the soil. Indicating either maize or ragi should be included in crop rotation.

Succession cropping :

The system of growing two or more crops in succession on the same land within a year. The cropping system is generally followed in most market gardens where the aim is to keep the high priced land occupied with the cash crops for most part of the year. The succeeding crop is planted after the preceding crophas been harvested in which crop intensification is only in the time dimension. The sowing of succeeding crop and harvesting of the preceding crop may be done simultaneously or in a quicksuccession *e.g.,* soon after harvesting of okra, potato is sown or after digging of potato, chilli isplanted. It is also called as non-overlapping

crop because of no overlapping between two or morecrops.

The basic advantage of sequential cropping system is there is no intercrop competition and Growers manage only one crop at a time in the same field.

Examples of succession cropping followed in West Bengal :

– Potato (oct to jan) –Onion (Jan-may)-Okra (May-Oct)

– Chilli (June-Nov)-Pea (Nov-March)-Amaranth (March-June)

– Pumpkin (Oct-Feb)-Okra (Feb-may)-Brinjal (May-Oct)

– Radish (Oct-Dec)-Watermelon (Dec.-April)-Bottle gourd(April-oct)

– Okra(Feb-July)-Brinjal (July-Feb)

Intercropping :

Growing of two or more crops simultaneously on the same piece of land in distinct row arrangement is termed as intercropping. The crops may or may not be sown /planted and harvested at one time. It is mainly aimed at increasing the yield of the companion crop without reducing yield of main crop. Following intercropping, the cropping intensity in space dimension is increased. The crops utilize resources efficiently and productivity of land is increased. The crop also serves as an assurance of crop failure. However while selecting crops care should be taken that their nutritional requirements should not be overlapping, there should be competition for light and component crop should be complementary for each other.

Gautam *et al.* (2007)conducted an experiment on effect of shoot and fruit borer on intercropping in okra .The okra crop grown in mix crop with cowpea, moong, marigold and sole okra. The maximum infestation of shoot and fruit borer was observed on okra followed by okra + moong whereas minimum on okra + marigold followed by okra + cowpea.

Bavec *et al.* (2012) studied productivity and growth of vegetables planted as intercrops were investigated in a three-year experiment according to organic farming rules in the northeast of Slovenia and observed thatthe market yield of cabbage as a sole crop (41.07 t ha^{1}) did not differ to intercropping production with salad and red beet; yields of cabbage in intercropping with celery, leek, beans and tomato were significantly lower. All intercrops had land equivalent ratios (LER) >1.00 and the highest LER (1.62) was reached in cabbage and tomato intercropping due to the same density of tomato as an intercrop and as a sole crop. The intercropping production of white cabbage with the studied vegetables is more productive than sole cropping in terms of land use efficiency.

Suresha *et al.* (2007) studied the effect of different intercrops *viz.*, radish, carrot, onion, garlic, cluster bean and dolichos bean on chilli. Significantly the highest (75.16 q/ha) yields were obtained in sole chilli. Yield of chilli varied with different intercropping systems. Radish + chilli intercropping system results in realization of significantly the highest (72.05 q/ha) yield in chilli followed by chilli + carrot (70.77 q/ha). On the contrary 'chilli + cluster bean' resulted in lower yield of 64.43 q/ha. Further, economic analysis was also carried out. The highest net returns (Rs. 59,261/ha) and B: C ratio (1.75) was obtained in chilli, which was intercropped with garlic. On the contrary, the lowest net returns (Rs. 12744) and B: C ratio (1.01) was obtained in sole chilli.

Table 1 : Examples of intercropping in vegetables followed at different part of India

Main crop	Intercrops	Place of work
Okra	Beet root, knol-khol, Pea	Banglore (Karnataka)
Capsicum	Beet root, Knol-khol,Pea	Banglore (Karnataka)
Cabbage	Radhish, Turnip, Methi, Palak	Hisar (Haryana), Akola (Maharashtra)
Cauliflower	Radhish, Palak	Akola (Maharashtra)
Chilli	French bean, Onion	Dharwad (Karnataka)
Tomato	Spinach, Onion, Radhish	Hisar (Haryana)
Pigeonpea	Urd, Moong, Cowpea, Okra	New Delhi

Source: Singh (1997). Cropping systems in vegetable crops, Principles of Vegetable production. Agrotech Publishing Academy

Relay cropping :

It is also the system of growing different crops on the same land within a year but in this system succeeding crop is sown/planted before the preceding crop is ready for harvest. So, growing span of two crops overlaps for a short period. Relay cropping is practiced in some cases, like planting of rabi onion seedlings in the standing crop of cabbage which may be almost reaching maturity for harvest. Planting of chilli in sweet corn field and sowing of cucurbits in potato field are the most common example of vegetable based relay cropping. By adapting this system early crop can be sent to the market for getting

premium prices. The main advantage of relay cropping is that, there is no need of land preparation for sowing/ planting thereby reducing cost of cultivation.

Examples of relay corpping followed in West Bengal:

– Potato : Pumpkin (Potato is harvested in march and pumpkin seeds are sown in last week of January. After harvesting of Potato ,pumpkin is continued upto August

– Early cauliflower-Pumpkin (cauliflower seedlings are transplanted in August and harvested in November. Pumpkin seeds are sown in October in standing crop of cauliflower and continued upto march.

– Bittergourd-Okra (Bitter gourd is grown during October to March. Pre germinated seeds of okra are to be sown in February and continued upto june

In relay cropping in vegetables, vegetable cultivation is followed from October to May (8 months).In the beginning two or more crops of different durations are cultivated in the same field. When vegetables of shorter duration is harvested second vegetable gets better space to grow. When second vegetable enters fruiting phase,a third vegetable is planted and likewise with modified principles of mixed and relay cropping the farmers took 3 to 7 crops in same patch of land over a period of 8 months (ICAR Report).

Mixed cropping :

Mixed cropping deals with growing two or more than two crops simultaneously on the same piece of land without define row pattern or fixed ratio by mixing the seeds of crops intended to be grown mixed or sowing alternate rows in various ratios. It is commonly practiced in dry land areas. Sometime intercropping and mixed cropping are treated synonymous to each other or mixed cropping is identified as a type of intercropping. It is practiced with a view of minimized risk in the farming. It is a type of subsistence farming and it favours fulfilment of different needs of the family.

Reynafarje *et al*. (2016) reported that. The tomato-lettuce association obtained the highest percentage of premium quality fruits according to local market standards. The LER of the tomato-lettuce and tomato-green bean was 1.3 and 1.2, respectively. They concluded that mixed cropping can lead to additional production opportunities. In addition to the tomato production, 30% more lettuce and 20% more green bean can be obtained without compromising tomato yields and dry matter content.

Table 2 : Vegetable based mixed cropping systems

Main crop	Associated crop
Potato	Radish
Potato	Coriander
Cabbage	Lettuce+Radish
Cauliflower	Radish
Okra	Radish
Brinjal	Radish
Cowpea	Clusterbean

Source: Singh (1997). Cropping systems in vegetable crops, Principles of vegetable production. Agrotech Publishing Academy

Conclusion :

The objective of any cropping is to maximise the resource use (soil, water, sunlight, vegetation, humans and animals). This can be achieved through identification of crop adaptation zones for maximum productivity, based on soil, climate and management strategy. As food crops, vegetables constitute a very important role because of higher productivity in a short time along with year round availability. We immediately need to to add sustainability dimension to our agriculture production system to improve the productivity of vegetables at the maximum. Adopting suitable cropping systems is one of the best possible options to improve the resource use efficiency under changing climate scenario.

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REFERENCES

Bavec, M., Zuljan, Robacer and Bavec, F. (2012). White cabbage productivity in intercropping production systems. *Acta Horticulture*.

Bhardwaj, M.L. (2012). Effect of Climate Change on Vegetable Production in India

Bose, T.K., Som, M.G. and Kabir, J. (1993). *Vegetable Crops*. Naya Prakash, Calcutta (Page 1 to 3)

Gautam, H.K., Singh, N.N. and Rai,A.B. (2015). Effect of intercropping on infestation of shoot and fruit borer (*Earias vitella*. Fab) on okra. *Veg. Sci*., **42**(2):68-70

Hazra, P. and Som, M.G. (2015). *Vegetable Science*. Kalyani

Publishers, Ludhiana (pp. 117-23)

Kishore, Kundan, Monika, N., Rinchen, D. and Boniface, Lepcha (2014). Sequential vegetable production under protected condition in temperate humid region.*Indian J. Agric. Sci.*, **84**(1):170-173.

Reynafarje, X.,Siura,S. and Perez, K. (2016). Mixed cropping of vegetables to improve organic tomato (*Solanum lycopersicum* L.) production in small farmer systems. *Acta Hort.*,

Sharma, J.P. and Kumar, S. (2004). Effect of crop rotation on population dynamics of *Ralstonia solanacearum* in tomato wilt sick soil. *Indian Phytopath*., **57** (1) :80-81

Singh, A. (1972). Conceptual and experimental basis of cropping patterns. *In*: *Proceedings of symposium on Cropping Patterns in India*. ICAR, New Delhi

Singh, Jitendra (2010). *Basic Horticulture*. Kalyani Publishers, Ludhiana (Page192-94)

Singh, K. (2004). Transformation of Vegetable Science in India Looking Back and Ahead, *Financing Agric.*, (Oct.-Dec.), pp. 15-28.

Singh, R.P., Pande, Padmaja, Solankey, S.S. and Chatterjee, Antra, *Fundamentals of vegetable Production*, Chapter 19 (page 347-58)

Singh, S.P. (1997). *Cropping systems in vegetable crops, principles of vegetable production*. Agrotech Publishing Academy.

Suresha, B.A.,Allolli ,T.B., Patil, M.G., Desai, B.K. and Hussain, Syed Abbas (2007). Yield and economics of chilli based intercropping system. *Karnataka J. Agric. Sci.*, **20** (4) : 807-809.

Swarup, Vishnu (2014). *Vegetable science and technology in India*. Kalyani Publishers, Ludhiana (pp. 161-63)

Willey, R.W., Singh, R.P. and Reddy, M.S. (1989). Cropping systems for Vertisols in different rainfall regimes insemiarid tropics. *In*: *Management of Vertisols for improved agricultural production*. ICRISAT, India

WEBLIOGRAPHY

NHB Database 2014

www.tradingeconomics.com

www.icar.org.in