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RESEARCH ARTICLE :

Technological gaps in major vegetable crops and suggestions to sustain the vegetable production

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SUMMARY : Vegetables provide smallholder farmers with much higher income and more employment than staple crops. Even though vegetable area is higher in India, the farmers who produce vegetable crops, struggle a lot to bring them up. A wide gap exists between the yields obtained and the potential yields due to non-adoption of scientific technologies. Keeping this in view the study was conducted with 90 vegetable growers in Madurai district of Tamil Nadu, India to assess the real technological gaps and yield gaps. The results showed that the major yield gap is due to increasing intensity of pest and diseases and physiological disorders due to climate change *viz.*, fruit borer (70.00 %), blossom dropping and less fruit setting percentage (68.33 %), sunscald due to high temperature (61.66%), fruit cracking (53.33 %), deformation of fruit and lower quality (51.66%), yellow or green fruit shoulders (46.66%) and okra curling/small size of fruit and hardness of fruit (40.00 %). The major technological gaps are due to non-application of foliar spray / micronutrient spray /growth regulators (100.00 %), non-adoption of IPM packages (77.77%), seed treatment practices with biofertilizers and bio agents (56.66 %), application of recommended quantity of top dressing (63.33) and mulching (50.00%). Improved package of practices can decrease the technology gap; thereby productivity of the crop can be increased.Training programme on improved vegetable production technology along with multiple demonstrations is required to enhance level of knowledge and skills which increase the yield and income.

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BACKGROUND AND OBJECTIVES

Vegetables are the store houses of most of the vitamins and minerals and also proteins. The importance of vegetables in providing balanced diet and nutritional security has been realized world over. India is havingan area of 10.1 million hectares and it is the largest producer of ginger and okra and ranks second in production of potatoes, onions, cauliflowers, brinjal, cabbages, etc. Tamil Nadu state of India has nearly 3 per cent of vegetable cultivation area and 5 per cent of vegetable production of the country. The vegetables such as brinjal, drumstick, ladies finger, tomato, onion and greens are being grown.

Even though the area is higher, the farmers who produce vegetable crops, struggle a lot to bring them up. Even at the time of producing the crops and at the time of

selling them, they face a lot of hurdles and obstacles such as the interference of brokers and middlemen, lack of insurance facility, lack of finance, high cost of inputs, problems related to storage of the produce and transportation which render the vegetable production unprofitable. Being a short term crop (3-4 months) and having a lower shelf-life, fast disposal is important for both growers and buyers. Hence, Small and marginal farmers hitherto cultivating vegetables under conventional method are struggling a lot.

Hence, a wide gap exists between the yields obtained and the potential yields. It is mainly because of poor knowledge as well as non-adoption of scientific technologies of vegetable cultivation. By adopting improved varieties and technologies, production and productivity of vegetables can be increased. Apart from this the climate change is the primary cause of low production of most of the vegetables worldwide; reducing average yields for most of the major vegetables. Moreover, increasing temperatures, reduced irrigation-water availability, flooding and salinity will be the major limiting factors in sustaining and increasing vegetable productivity (Ericksen, 2008). As many physiological processes and enzymatic activities are temperature dependent, they are going to be largely affected. Drought and salinity are the two important consequences of increase in temperature worsening vegetable production.

Keeping the above situations in mind, an attempt has been made to assess the technological and yield gaps and factors reducing the productivity are very essential to boost up the vegetable cultivation in order to stabilize the productivity and to ensure assured income to farmers in the rural areas.

RESOURCES AND METHODS

In Tamil Nadu, Madurai district is purposively selected based on the highest area under vegetables. In Madurai district, Chellampatti block was selected based on the highest area under vegetable cultivation. The study was conducted during the month of April-June of 2018. During the study period the area was worst affected by drought, high temperature, water scarcity, physiological problems and pest and disease outbreak due to climate change. 90 respondents were selected @ 30 farmers cultivating tomato, brinjal and ladies finger. Interview schedule was constructed, pre-tested and finalized and used for collecting data.Relevant data collected pertaining to the study was analyzed interpreted and meaningful conclusions were drawn.

OBSERVATIONS AND ANALYSIS

The yield gap and technology gap for major vegetable crops were worked out and the results are presented in the following Table 1. From the Table 1 it is seen that for the tomato hybrid variety Shivam the yield gap is 6.4 t/ac. The research station yield of tomato is 38.4 t/ac. The average farmers yield is 32 t/ac. The technology index of tomato is 6.25. The extension gap is 4t/ac. With regard to brinjal the research station yield is 32 t/ac and average farmers yield is 22.5 t/ac. Hence, the average yield gap I is 9.5 t/ac. In the case of bhendi, the yield gap I come around 3t/ac. The technology index is more in case of brinjal and okra (21.87 and 24.0)

If the extension gap is increasing, it emphasizes the need to educate the farmers through various means for the adoption of improved horticultural production. The trend of technology gap reflected the farmer's cooperation in carrying out such demonstration with encouraging results in subsequent years. The technology gap observed may be attributed to the dissimilarity in soil fertility status and weather condition. The technology index showed the feasibility of the evolved technology

Table 1 : Yield gap and technology gap in major vegetable crops

Crop and variety	Season	Potential yield (t/ac)	Demonstration yield	Average yield of farmers (t/ac)	Technology gap (PY-DY)	Technology index (PI-DY/ PYx100)	Yield gap I (t/ac) PY- FY	Extension gap/ yield gap II (DY-FY) (t/ac)
Tomato Hybrid : Shivam (Semi determinate)	Nov-Dec	38.4	36	32	2.4	6.25	6.4	4
Brinjal Hybrid-VNR Simran	Nov-Dec	32	25	22.5	7	21.87	9.5	2.5
Okra (Hybrid- Vairam)	Feb	10	7.6	7	2.4	24.0	3	0.6

at the farmer's field. The more the value of technology index, the less is the feasibility of the technology.

Improved package of practices can decrease the technology gap; thereby productivity of the crop can be increased. Therefore, target oriented training programme on improved vegetable production technology along with multiple demonstrations is required to enhance level of knowledge and skills of growers which ultimately lead to adoption of technologies.

Factors reducing the productivity in major vegetable crops:

With regard to tomato, it is observed from the Table 2 that, the intensity of pest and diseases and physiological problems was increasing due to climate change. Fruit borer (70.00 %), blossom dropping and less fruit setting percentage (68.33%), sunscald (61.66 %), tomato cracking or split tomato problem (53.33%), yellow or green tomato shoulders and deformation of tomato fruit (51.66%), yellow or green tomato shoulders (46.66%), blossom end rot (33.33%), hardness of fruit/ smaller size of fruit bearing (30.00%) and tomato fruit zippering (26.66%) were the major problems which leads to yield gap. This is in line with the findings of Ayyogari *et al.* (2014). With regard to brinjal the major problems are fruit and shoot borer (76.66%), brown streaking (36.66%) fruit rot /blossom end rot (40.00%) and small size and unsized fruit (30.00%). With regard to okra the major problems are hairy surface which causes itching in hands (56.66%), In okra, hairy surface-itching in hands (56.66%), fruit borer and powdery mildew (50.00%), okra curling/small size of fruit/discoloration and hardness (40.00%) and fibre content increasing (26.66%)

Now-a-days the infestation of pests due to climate change is increasing. Hence, 70.00 per cent of the farmers felt it as one of the reasons for yield gap. Pre-anthesis temperature stress is associated with developmental changes in the anthers and pollen formation includes bud drop, abnormal flower development, poor pollen production, dehiscence, poor viability and other reproductive abnormalities. Other reasons for blossom drop on tomatoes are insect damage, lack of water, too much or too little nitrogen and lack of pollination. Hence, this was felt as important factor for yield gap. The sunscald often especially prevalent when maturing fruit suddenly becomes exposed to the direct rays of the sun. High temperatures caused significant losses in tomato productivity.

Fluctuation of temperatures and a lack of water and too much water after a dry spell cause the skin to split or tomato cracking. Hot, rainy weather also causes fruit crack. After a long dry spell, tomatoes are thirsty. Plants may take up water rapidly after the first heavy rainfall, which swells the fruit and causes it to crack. Hence,

Table 2 : Factors reducing the productivity in major vegetable crops

Crops	Factors reducing the productivity	Percentage of respondents
Tomato	Sunscald due to high temperature	61.66
	Tomato cracking or split tomato problem	53.33
	Deformation of tomato fruit	51.66
	Blossom dropping and less fruit setting percentage	68.33
	Tomato fruit zippering	26.66
	Hardness of fruit/ smaller size of fruit bearing	30.00
	Yellow or green tomato shoulders	46.66
	Fruit borer	70.00
	Blossom end rot	33.33
Brinjal	Fruit and shoot borer	76.66
	Fruit rot /blossom end rot	40.00
	Brown streaking	36.66
	Small size and unsized fruit	30.00
Okra	Bhendi curling/small size of fruit/dis colouration	40.00
	Hardness and fibre content increasing	26.66
	Fruit borer	50.00
	Hairy surface- Itching in hands	56.66

majority felt it as one of the factor for yield gap (Alam and Haseen, 2011).

In addition, significant inhibition of photosynthesis occurs at temperatures above optimum, resulting in considerable loss in terms of reduced fruit set, smaller and lower quality fruits. Further, water greatly influences the yield and quality of vegetables; drought conditions, water scarcity, less irrigation drastically reduce vegetable productivity. Increase in evapo-transpiration, leading to severe crop water-stress conditions. Thus, water greatly influences the yield and quality of vegetables; drought conditions drastically reduce vegetable productivity. Farmers expressed that for every 15 kg of tomato fruits 3 kgs are become waste due to this physiological disorders and pest and diseases.

Major technological gaps:

From the Table 3 it could be inferred that the major technological gaps are due to lack of high yielding varieties which are tolerant to high temperature, moisture stress, salinity has cent per cent technological gap. Soil testing and SHC recommendations, application of foliar spray / micronutrient spray/ growth regulators were having cent percentage technology gap followed by non-

Table 3 : Major technological gaps in crop operations of vegetable crops

Crop operations	Improved package of practices	Farmers practices	Gap	Percentage
Variety /HYV	High yielding varieties tolerant to high temperature, moisture stress, salinity	Not using recommended TNAU varieties and Hybrids only using Private HYV	Full gap	100.00
Soil testing and SHC recommendations	Have been done in all locations	Not in practice	Full gap	100.00
Seed rate seed priming	Seed priming was performed for better germination. Seeds were soaked during night for 8-10 hours with natural water, drained out excess water and dried in shade before sowing	Over use of seeds than recommended seed rate and priming is not done	Partial gap	61.11
Seed treatment	Seed was treated with Captan @ 2-3g /kg seeds or carbendazim @ 1 g /kg seed and with Imidacloprid @ 2.0 g /kg seed With bio fertilizers/ bio agents and field application	Partly in practice	Partial gap	56.66
Transplanting method	Transplanting in raised bed and distance row to row 120 cm and plant to plant 90 cm	Flat bed transplanting row to row 60 cm and plant to plant 30 cm	Partial gap	44.44
Fertilizer dose	Recommended fertilizer application (Transplanting to plant establishment stage)	Not applying recommendation	Partial gap	46.66
Top dressing	NPK fertilizers (Flower initiation to flowering and flowering to fruit set)	Not applying in proper quantity and in proper time	Partial gap	63.33
Mulching	with crop residues and plastic mulches	Not applying in full scale	Partial gap	50.00
Growth regulators	15 days after transplanting and at full bloom stage to increase the yield	Lack of knowledge	Full gap	100.00
Weed management	Pendimethaline @ 1.0 kg/ ha was applied immediately after transplanting	Hand weeding/rarely used	Partial gap	36.66
WSF spray	Foliar spray of 2% N:P:K 19:19:19 20,40,60 DAT	No application	Full gap	100.00
Plant protection	Need based in case of severe infestations and IPM packages	Non-application of recommended pesticides and chemicals/rarely used and without knowledge getting from pesticide shops	Partial gap	77.77

adoption of IPM packages (77.77%). Seed treatment practices with bio-fertilizers and bio-agents and field application, mulching with crop residues and plastic mulches and application of recommended quantity of fertilizers and top dressing were having technological gap ranging from 45.00 per cent to 65.00 per cent. These findings are in line with the findings of Mishra *et al.* (2010) and Singh *et al.* (2018).

Suggestions to sustain the vegetable productivity:

Due to the climate change and other factors the vegetable production is decreasing. The following were the suggestions taken into care for sustaining the production.

– Development of high yielding varieties tolerant to high temperature, moisture stress, salinity and climate proofing through conventional, non-conventional, biotechnology

– Improved nutrient-use efficiency, organic manures, bio fertilizers, bio-agents, mulching with crop residues

– The crop management practices like mulching with crop residues and plastic mulches help in conserving soil moisture.

– Protective coverings to reduce evaporation and conserving soil moisture

– Excessive soil moisture due to heavy rain becomes major problem that can be overcome by growing crops on raised beds.

– Development of genotypes tolerant to high temperature, moisture stress, salinity and climate proofing through conventional, non-conventional, breeding techniques, genomics and biotechnology etc. are essentially required to meet these challenges.

– Optimized pest management that is IPM approach are the key part of making sustainable use of other resources

– Improving farmers' knowledge on pesticide usage is important for the intensive agricultural inputs

– Vegetable value addition, awareness, capacity building and education on climate change are the ways to increase the productivity of vegetables.

– Extension officials can use learning videos as a crucial communication tool to help farmers to understand the technologies

Conclusion:

From this study it is clearly under stood that the technology and yield gap for major vegetable crops is increasing day by day due to climatic and other soil and environmental factors. It is the time to reduce the gap and to increase the productivity. Improved package of practices can decrease the technology gap; there by productivity of the crop can be increased. Therefore, target oriented training programmes on improved vegetable production technology along with multiple demonstrations is required to enhance level of knowledge and skills of growers which ultimately lead to adoption of technologies. Farmers should get aware of climate change and its impact on vegetable cultivation, optimum fertilizer application, pesticide usage and value addition in order to have sustained production and income.

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