



Vegetable intervention for livelihood and nutritional security of small landholders: key component for enhancing the income of farmers

R K YADAV¹, A K MISHRA², S K BANDYOPADHYAY³, B S TOMAR⁴ and H CHOUDHARY⁵

ICAR-Indian Agricultural Research Institute, New Delhi 110 012

Received: 22 September 2017; Accepted: 20 December 2017

ABSTRACT

Growing vegetable crops in Mewat poses a serious challenge due to its agro-climatology and edaphic characteristics. The main occupation of inhabitants in Mewat is agriculture and allied agro-based activities. Seeing the importance of area, an attempt was made to introduce vegetables cultivation at commercial level to increase the income of farmers and improve their livelihood condition. The introduction of crops, like tomato, brinjal and bottlegourd in Mewat has enhanced the farmer's income significantly and it has attained commercial status. Though income and yield enhancement was recorded at every farmer's level but some farmers who were mainly landless and practicing vegetable farming on rented land could increase their profit to a record level in a period of 3 years from 2011 to 2013. On an average basis in tomato, brinjal and bottlegourd, the yield increased up to 58%, 44% and 82% and profitability up to 49%, 48% and 55% respectively. If other interventions like, drip irrigation, Integrated Pest and Nutrient Management (IPM and INM), polyhouse cultivation, off-season nursery and vegetable production, efficient post-harvest handling with cool chain facilities, value addition and processing, contract farming etc. are added, the income and profitability may increase many folds. On over all basis, bottlegourd variety Pusa Naveen, brinjal variety Pusa Uttam and tomato hybrids Heemsohna and US 2853 were most demanding and fetched higher prices due to their high yield and fruit quality attributes. Therefore, it was proved that vegetable production is the emerging sector in agricultural diversification that would augment income of smallholders and generate employment opportunities in rural areas.

Key word: Farmers' income, Haryana, India, Livelihood, Mewat, Profitability, Vegetable cultivation

Mewat is the under developed area of Haryana, India, where agriculture and allied agro-based activities are the main source of income for inhabitants. The agriculture in whole Mewat is mostly rainfed, except in some pockets where canal irrigation is available. Agriculture production in terms of crop yield is low in Mewat compared to the other districts of the Haryana. Mewat continued to be a region of backwardness since independence as a result it lagged behind rest of Haryana on all fronts, even though the farthest point of Mewat is no farther than 145 km from the National Capital of India. Since most of the farmers are small and marginal (average land holdings of 0.2 to 0.4 ha) and more than 50% of villagers are landless labourers who works on others land or leased land. In spite of being close to National Capital Territory of Delhi, most of the advance technologies has not reached due to socio-economic structure of the region. Most of the farmers were growing mainly bajra, sorghum, mustard, sesame as main crop and some vegetables as backyard farming as subsistence farming, however there is great opportunity for commercial and

business oriented farming in the region as most of the areas are connected with major vegetable *mandies* (Vegetable wholesale market) of Delhi. Rural population including weaker section faces malnutrition and under nourishment which cause great loss to infant and children below 5 years. Besides nutritional security, cultivation of vegetables generally provide 2 to 5 times higher return than cereals per unit area and time, as such it is a viable proposition for the small and marginal farmers. With rising purchasing capacity and increasing health awareness among consumer, the demand for fruit and vegetables are rising day by day. This has clearly been seen by seeing the horticultural production. The way horticulture production has surpassed the total food grain production since 2012-13 and it has reached to 299.9 million tonnes in 2016-17 (NHB advance estimate 2016-17), this gave a hope for small landholders to double their income by growing vegetables, who's contribution is more than 80% in total horticulture production especially vegetables. This is mainly due to most of the vegetables being annual in nature and the short duration with regular source of income for small landholders who has less than 2 ha holding or cultivate on rented lands. Experiences gained in other developing countries suggest that diversification of agriculture towards high-value commodities and creation of non-farm employment opportunities have helped small

^{1,4,5}e mail: rkyadavneh@gmail.com, Division of Vegetable Science, ²Water Technology Centre, ³Centre for Environmental Science and Climate Resilient Agriculture.

landholders to augment their incomes and bail them out of the vicious circle of poverty (Ryan and Spencer 2001). A world bank report (World Bank 2005) indicated that agriculture plays a key role for economic development of rural poor and poverty reduction (Irz and Roe 2000) with evidence indicating that every 1% increase in agricultural yields translates to 0.6 to 1.2% decrease in the percentage of absolute poor (Thirtle *et al.* 2002). In 2001, smallholders contributed 55% to the total production of fruits and vegetables, up from 51% in 1991 and 43% in 1970-71 (Singh *et al.* 2002). The share of smallholders in production of fruits and vegetables is likely to go up further. Numerous studies indicate that farmers are gradually shifting towards high-value commodities, particularly fruits and vegetables. Studies also reveal that fruits and vegetables offer immense scope to increase income levels of smallholders and improve the productivity of scarce resources (Pingali and Rosegrant 1995, Chand 1996, Joshi *et al.* 2003).

To encourage the farmers for growing more and more vegetables and also to increase awareness for advantage of vegetables in mitigating health and nutrition problems intervention of vegetables was planned. It was perceived that if simply the high yielding varieties/hybrids are introduced into the area, the productivity of these crops can be enhanced. In view of this, the technological interventions and field demonstrations were planned in four villages of Nuh block, viz. Biwan, Sounkh, Palla and Palladi for 3 consecutive years from 2011 to 2013 to improve their livelihood condition as marketing was not a problem for them being near to Delhi. So in this process improved varieties and hybrids of different vegetable crops were introduced along with package of practices for commercial cultivation as one of the component of livelihood improvement programme.

MATERIALS AND METHODS

Introduction of improved varieties of vegetables was undertaken during 2011 to 2013 in Biwan cluster of villages, i.e. Biwan, Palla, Palladi, Sounkh of Nuh block of Mewat district of Haryana, India. Mewat is situated at 28° 06' N and 77° 00' E; and at altitude of 200 m above mean sea level. It is located in the far south west area of Haryana. It falls under the sub-tropical, semi-arid climatic zone with extremely hot temperature in summer. Dryness of air is standard feature in Mewat except during the monsoon season. May and June are the hottest months of the year with the temperature ranging from 30°C to 48°C. January, on the other hand is the coldest month with temperature ranging between 2°C to 25°C. Strong dusty winds are conspicuous during summer. Precipitation occurs during monsoon period from June to September when about 80% of the rainfall is received. The average rainfall varies from 336 mm to 440 mm. Soils of the Mewat district are mostly salt affected. The soils are medium textured loamy sand and falls in low to medium category with 0.2 % to 0.75% organic content. The average conductivity of the soil is not more than (0.80 μ mhos/cm) and the average pH of the soil is between 6.5 to 8.7. The PRA survey revealed that

agriculture is main source of livelihood of the people. It was found that many farmers are already growing vegetables in small level, but unscientifically, therefore, it was realised that if they are provided improved varieties /hybrids along with sound technological backup, the farmers can improve their livelihood condition. The major problems of area were identified through Participatory Rural Appraisal (PRA) and the villagers ranked the problems in the scale of 1-10, 1 being the most important problem. Poverty and lack of employment were ranked as number 1 problem. Low productivity and poor soil health were identified as number 2 and 3 respectively. Since lack of employment and poverty are directly related to socio-economic development and indirectly with the agricultural activities, poor crop productivity and soil health were identified number one problem of agriculture. It was observed that farmers were raising nursery on flat bed, which caused poor seed germination and high seedling mortality. As the seed cost of hybrids were very high, i.e. on an average ₹ 30000 per kg, therefore, it was realised that we should try to save each and every seed by introduction of high yielding open pollinated varieties and hybrids of public sector in general and private sector popular hybrids in specific condition along with adopting scientific/advance techniques of nursery raising. Keeping above in view, the programme was undertaken to address these issues.

Systematic efforts were made to improve the livelihood of farmers by various interventions to make the agriculture a profitable venture in phased manner. (i) Nursery raising under protected condition with improved nursery raising techniques. (ii) Installation of insect proof protected structure for raising nursery. (iii) Installation of poly house structures (for winter season) and shade net/insect proof nets (for summer season) for off-season and healthy nursery/crop production. (iv) Introduction of improved vegetable varieties/hybrids both from public and private sector. (v) Drip/sprinkler system of irrigation for vegetable cultivation. (vi) Scientific and early growing of vegetables to tap the market. (vii) Use of integrated disease and pest management strategies.

RESULTS AND DISCUSSION

Demonstration of vegetable nursery raising techniques

The tomato, brinjal, bottle gourd, chilli and cauliflower nurseries were raised under insect proof net house on raised bed, plug tray, etc. as well as in open field condition. The seed germination and seedling growth were found better in protected condition. The mortality was low inside net house. Seedlings developed were early and disease free. Cost of raising seedlings was worked out to be ₹ 0.50/seedling, while approximate sale price of seedling was ₹ 2.0/seedling (Table 1).

Under low cost protected structure of 50 m² a total of ₹ 9500 was earned in first year in two month and around ₹ 25000 from second year onwards by raising off-season nursery.

Table 1 Performance of vegetable nursery raising under net house in Mewat

Crop	Mortality (%)		Days taken to transplantable height (10-12 cm)	
	Open	Net house	Open	Net house
Tomato (<i>Solanum lycopersicum</i>)	50	5	35	25
Chilli (<i>Capsicum annum</i>)	30	8	55	40
Cauliflower (<i>Brassica oleracea</i> var. <i>botrytis</i>)	20	2	40	30

Economics of raising nursery under poly house

Size of structure (10m (L) × 5m (W) × 7' (H)) = 50m²

No. of seedlings 8 000 (polybags) + 7 000 (portrays) = 15000

Seedling @ ₹ 2/- = ₹ 30 000

Investment cost (polyhouse, polybags, portrays etc.) = 15 500 + 5000 = ₹ 20 500

Net profit 1st year (30 000 – 20 500) = ₹ 9 500

Net profit 2nd year and 3rd year (30 000 – 5 000) = ₹ 25 000

Introduction of vegetable crops in Biwan cluster, Nuh, Mewat (during 2011-12)

The vegetable intervention was started since *kharif* 2011 in 4 villages, namely Biwan, Palla, Pallari, Sounkh of Biwan cluster of Nuh, Mewat district of Haryana with introduction of high yielding varieties and hybrids. In the first year, mostly the improved varieties/hybrids developed at ICAR-IARI, New Delhi were introduced along with some popular hybrids of private sector at small scale. In beginning several crops based on interactions were selected for introduction. The vegetable crop introduced during 2011 is given in Table 2.

During 2011 *kharif*, out of various vegetables okra variety Pusa A-4 gave profit of ₹ 45 000/ha, cowpea variety Pusa Sukomal ₹ 40 000/ha, brinjal ₹ 65 000/ha and bottle gourd ₹ 60 000/ha. These crops were grown first time in that area and farmers were satisfied with the performance of the crops.

In winter/*rabi* season of 2011 several crops namely palak, pea, methi, vegetable mustard and tomato were introduced, but tomato was found highly profitable. From tomato farmers earned ₹ 73 000 to 85 0000 from one ha land by growing open pollinated and hybrids varieties respectively (Table 3).

Introduction of vegetable crops in Biwan cluster, Nuh, Mewat

After observing the performance of various vegetables in *kharif* and winter season of 2011-12, the demonstration was extended to different villages by covering 36 farmers

Table 2 Vegetables introduced and profit earned during *kharif* 2011

Crop	Variety	Quantity	Area covered (ha)	Profit (₹) from actual area covered	Yield estimated (t/ha)	Profit estimated (₹/ha)
Okra (<i>Abelmoschus esculentus</i>)	Pusa A-4	3 kg	0.2	9 000	10.0	45 000
Cowpea (<i>Vigna unguiculata</i>)	Pusa Sukomal	2 kg	0.1	4 000	8.0	40 000
Brinjal (<i>Solanum melongena</i>)	Pusa Uttam (round)	100 g	0.2	13 000	40.0	65 000
Bottle gourd (<i>Lagenaria siceraria</i>)	Pusa Naveen (long)	0.5 kg	0.1	6 000	30.0	60 000

with average area coverage of 0.20 ha/farmer in the year 2012. The crops like, tomato, brinjal and bottlegourd were found highly suitable and demanding, therefore, demonstrated at commercial scale. Twelve farmers each for tomato, brinjal and bottle gourd were selected from all the villages.

Bottle gourd seeds were sown in polybags/ portrays in the month of June under shade net and seedling were transplanted in July after removing polythene by cutting and whole earth ball was placed at respective places in channels. Fruits of bottle gourd variety Pusa Naveen were tender and retained green colour for longer period and fetched higher

Table 3 Vegetables introduced and profit earned during winter and spring-summer 2011-12.

Crop	Variety	Quantity of seed	Area covered (approx.)	Estimated yield (t/ha)	Profit (₹/ha)
Palak (<i>Beta vulgaris</i> var. <i>bengalensis</i>)	Pusa Bharati	2 kg	0.1 ha	20.0	40 000
Pea (<i>Pisum sativum</i>)	Arkel	50 kg	0.75 ha	8.0	45 000
Methi (<i>Trigonella foenum graecum</i>)	Pusa Early Bunching	4 kg	0.2 ha	10.0	30 000
Vegetable mustard (<i>Brassica juncea</i>)	Pusa Sag 1	5 kg	1 ha	30.0	70 000
Tomato (<i>Solanum lycopersicum</i>)	Pusa Rohini	100 g	0.2 ha	37.5	73 000
	Pusa Hybrid 8	50 g	0.3ha	40.0	85 000

Table 4 Performance of different vegetables introduced during *kharif* 2012-13

Crop	Variety	Yield (t/ha)	Income (₹/ha)	Expenditure (₹/ha)	Av. Profit (₹/ha)	Profit range (₹ lakh/ha)
Bottle gourd	Pusa Naveen	36.0	119000	50000	69000	0.61-0.75
	Mahyco Hybrid No.8	35.5	116000	52000	64000	0.50-0.75
Tomato	Pusa Hybrid 8	35.0	200000	100000	100000	0.65-1.00
	Heemsohna	40.0	240000	107000	133000	1.10-1.40
	US 2853	45.0	250000	95500	145000	1.23-1.75
Brinjal	Pusa Uttam (round)	30.0	173000	85000	88000	0.65-0.90
	Pusa Hybrid-5(long)	35.5	186000	92000	92000	0.72-1.10
	CV (%)	12.5				
	CD (5%)	4.5				

prices. In case of Pusa Naveen, fruiting was also recorded for longer period from August to December, however Mahyco No. 8 recorded late fruiting and it was found susceptible to bud necrosis virus. In case of bottle gourd, variety Pusa Naveen recorded an average profit of ₹ 69000/ha as compare to Mahyco No. 8, which recorded ₹ 66000 average profit, however, the maximum profit recorded by both varieties was ₹ 75000 per ha. In brinjal Pusa Uttam, a round fruited variety was most liked by farmers due to its attractive dark purple colour and shining fruits. Pusa Uttam gave a profit range of ₹ 65000 to 90000/ha with average profit of ₹ 88000 per ha. In tomato US 2853 was found most profitable and high yielding which exhibited average profit of ₹ 145 000 per ha. Tomato hybrid Heemsohna and US 2853 were found most suitable for transplanting from November to January and fruiting was recorded from February to May. The farmers earned very high profit from these two hybrids. Sudha *et al.* (2006) reported that Commercial Seed Production (CSP) in vegetables, like tomato and okra is an important economic activity for farmers in the dry regions like Haveri and Gadag in Karnataka providing assured returns and additional employment. Similarly the Das *et al.* (2014) found significant impact of vegetable interventions at farmers' field in Meghalaya and reported that productivity has gone up by 30–40% in potato and 45-50 % in rice with the introduction of improved package of practices for various crops, availability of irrigation water and integration of different components. Therefore, the high yielding varieties of vegetables have been effective in enhancing the income of small landholders significantly.

Table 5 Profit earned by the farmers in ratoon crop of brinjal during 2012-13

Crop	Variety	Profit (₹)/ha	Remarks
Brinjal	Pusa Uttam (round)	55000	Farmers earned high prices in ratoon crop
	Pusa Hybrid-5(long)	50000	
	Pusa Hybrid-9 (round)	57000	

Profit earned by the farmers in ratoon crop of brinjal

The brinjal crop of *kharif* season was left as such in the field during winter season after completion of *kharif* crop in the month of December. This crop is saved during winter with mild irrigation to avoid adverse effect of frosting. In the month of February the ratoon crop was irrigated, weeds were cleaned and chemical fertilizers were applied which resulted in flowering and fruiting from March and continued up to June. The ratoon crop fetched higher prices, though the production was around 50-70% of *kharif* season. An additional income of ₹ 50 000/ to ₹ 57000 was earned by some of the farmers (Table 5). Fruit of Pusa Uttam was attractive, glossy and deep purple in colour and fetched higher prices. While, Pusa hybrid 5 was found 15 days earlier in fruiting than private sector hybrids. Brinjal varieties Pusa Uttam and Pusa Hybrid 5 recorded fruiting at high temperature during May-June. It had better taste as reported by farmers and was free from diseases, however private hybrids recorded disease like, little leaf of brinjal.

Performance of vegetable crops in Biwan cluster, Nuh, Mewat

During *kharif* 2013, a large number of small farmers were selected for different vegetables, like tomato, brinjal and bottlegourd in 4 adopted villages consisting of Biwan, Palla, Pallari, Sounkh under Biwan cluster. Improved varieties and hybrids of vegetables were given for commercial cultivation under livelihood improvement programme. Brinjal transplanting was started from July onwards. Seeds of bottlegourd were sown in poly bags in June under shade net and one month old seedlings were sown in channels during first week of July. Similar to previous year the bottle gourd variety Pusa Naveen recorded tender and green fruits for longer period and fetched higher prices. In brinjal Pusa Uttam and Pusa Hybrid 5 fetched higher prices due to dark purple and tender fruits (Table 6). Private sector hybrid Nun 707 also recorded very high yield but due to light purple and large sized fruit and susceptibility to little leaf disease of brinjal it was less preferred by farmers. In third year, the crops, like tomato, brinjal and bottle gourd attained commercial status. Now the farmers were well versed with vegetable cultivation. It was also found that some farmers could increase their profit to a record level, for example, from bottlegourd maximum earning was recorded by Hashnu from Palladi village, i.e. ₹ 2 lakhs from one ha area by selling around 50 tonnes fruits from variety Pusa Naveen. Seeing this, a great demand for Pusa Naveen was generated and some of the farmers started its seed production. It was also noticed that during 2013,

Table 6 Average yield and income earned by farmers during 2013-14 from various crops

Crop	Variety	Yield (t/ha)	Average profit (₹)/ha
Brinjal*	Pusa Uttam (round)	40.0	130000
	Pusa Hybrid-5(long)	42.0	135000
	Pusa Hybrid-9 (round)	48.0	145000
	Nun-707	55.0	150000
Bottlegourd	Pusa Naveen	45.0	155000
	Mahyco No.8	46.0	135000
Tomato	US-2853	50.0	155000
	Heemsohna	45.0	143000
	CV (%)	8.6	
	CD (5%)	3.8	

*Profit of brinjal include ratoon crop also.

the farmers got high prices of vegetables as compared to previous years and their income also increased significantly after 3 years (Table 7).

Previous studies have suggested that farmers growing tomatoes during the *kharif* season have received high profits. Zaman *et al.* (2010) analyzed on-station data from experimental plots and showed that every dollar (USD) invested in off-season tomato production gave revenues of 3.3 dollars (benefit cost ratio). Consumption of vegetables increased by 50% in the viallages after intervention which helped in ensuring nutritional security at household level. Schreinemachers (2016) found that for the average smallholder vegetable farmer, training increased net household income by about 48% in Bangladesh. The policy implication is that while off-season vegetable production can create dramatic income improvements, it is important to emphasize safe and sustainable pest management methods as part of policies promoting it. It was also noticed that the small landholders were more interested in vegetable production than large. Unit cost of production was lesser in small landholder due to efficient management. Non-availability of good quality seed was found as one of the factor for reduced profitability.

The introduction of high-yielding varieties of vegetables along with improved cultivation practices, viz. early and healthy seedling raising techniques, use of sprinklers and drip, levelling of land, raised bed tomato and brinjal cultivation, channels cultivation of bottlegourd, ratooning of brinjal, crop rotation, as well application of integrated pest management practices, like pheromone traps, yellow sticky traps, marigold planting along the irrigation channels etc. were found very effective in controlling the pest and enhancing the farmers income in bottlegourd, tomato and brinjal. For example the per ha profit of bottle gourd variety Pusa Naveen increased from ₹ 60000 to ₹ 200000 and brinjal variety Pusa Uttam from ₹ 75000 to ₹ 135000. The ratoon crop of brinjal fetched higher prices, though the production was around 50-70% of *kharif* season. An

Table 7 Enhancement of yield due to introduction various crops

Crop	Average yield (t/ha) (under local variety and practices by farmers)	Average yield (t/ha) After introduction of improved varieties and practices	% yield increased over local variety and practices	% income enhancement
Tomato	30	47.5	58	49
Brinjal	32	46.3	44	40
Bottlegourd	25	45.5	82	55

additional income of ₹ 50000 to 57000 was earned by some of the farmers. It was also reported by farmers that bottle gourd Pusa Naveen fetched very high price (2-3 rupees more than Mahyco No.8) due to its cylindrical shape, dark green colour and longer shelf-life. Similarly, brinjal Pusa Uttam was preferred in the market because of shining dark purple colour and tender round fruits at marketable stage. Tomato hybrids Heemsohna and US 2853 were found high yielding. Thus, the intervention of vegetable varieties along with package of practices has played a key role in improving the livelihood of the farmers besides proving nutritional security. The results clearly revealed that vegetable production is more profitable and labour-intensive, therefore it fits well in the small farm production systems. The smallholders are relatively more efficient in production and own more family labour in contrast to large farmers. It was felt that low marketing surplus of small landholders require formation of cooperative groups or contract farming with *safal* or other agencies to reduce transportation cost.

REFERENCES

- Chand Ramesh. 1999. Diversification through high value crops in western Himalayan region: Evidence from Himachal Pradesh. *Indian Journal of Agricultural Economics* 41(4): 652-63.
- Das Anup, Munda G C, Azad Thakur N S, Yadav R K, Ghosh P K, Ngachan S V, Bujarbaruah K M, Lal B, Das S K, Mahapatra B K, Islam M and Dutta K K. 2014. Rainwater harvesting and integrated development of agri-horti-livestock-cum pisciculture in high altitudes for livelihood of Tribal farmers. *Indian Journal of Agricultural Sciences* 84 (5): 643-9.
- Irz X and Roe T. 2000. Can the world feed itself? Some insights from growth theory. *Agrekon* 39 (3): 513-28.
- Joshi, P K, Gulati A, Birthal P S and Tewari L. 2003. Agricultural diversification in South Asia: Patterns, determinants and policy implications. MTID Discussion Paper No. 57, International Food Policy Research Institute, Washington DC, USA.
- National Horticulture Board. 2017. Third advance estimate of 2016-17 area and production of Horticultural crops, Ministry of Agriculture, Government of India. www.nhb.gov.in/.
- Pingali PL and Rosegrant M W. 1995. Agricultural commercialization and diversification: Processes and policies. *Food Policy* 20(3): 171-86.
- Ryan J G and Spencer D C. 2001. Future Challenges and Opportunities for Agricultural R&D in the Semi-arid Tropics. International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Andhra Pradesh, India.

- Schreinemachers Pepijn, Wu Mei-huey, Uddin Md. Nasir, Ahmad Shahabuddin and Peter Hanson. 2016. Farmer training in off-season vegetables: Effects on income and pesticide use in Bangladesh. *Food Policy* **61**: 132–40.
- Singh R B, Kumar P and Woodhead T. 2002. Smallholder Farmers in India: Food Security and Agricultural Policy. FAO Regional Office for Asia and the Pacific, Bangkok, Thailand.
- Sudha M, Gajanana T M and Murthy Sreenivasa D. 2006. Economic impact of commercial hybrid seed production in vegetables on farm income, employment and farm welfare – A case of tomato and okra in Karnataka. *Agricultural Economics Research Review* **19**: 251–68.
- Thirtle C, Beyers, L, Lin L, Mckenzie-Hill V, Irz X, Wiggins S and Piesse J. 2002. The impact of changes in agricultural productivity on the incidence of poverty in developing countries. DFID report no. 7946, Department for International Development (DFID), London, UK.
- Zaman M, Hemel R A and Ferdous T. 2010. Comparative profitability of winter vegetables in a selected area of Dhaka district. *ASA Univ. Rev.* **4**(1): 217–23.