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Impact of technological interventions on farmers' income and employment in the Trans-Gangetic Plain region

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ABSTRACT

Agriculture is a cornerstone of India's economy, employing around half of the workforce. However, a very large proportion of agricultural land in India does not have the desirable productivity, which diminishes the prospects for reasonable income to the farmers. Recognizing this challenge, a study on agricultural practices and income of 640 farmers of 32 villages in Haryana was conducted during the period 2016–17 and 2020–21. The analysis revealed an increase in productivity and consequent income of the farmers with varying degrees. The growth in productivity and income was more conspicuous in adopted villages due to technological interventions such as introduction and adoption of high yielding verities/hybrids/breeds, scientific management practices, resource conservation technologies, cost reduction measures and supplementary enterprises, etc. as compared to non-adopted villages. The income augmentation was noticed in field and horticultural crops, livestock and subsidiary enterprises. The highest increase in income was registered with high value commodities. Inter-district variations were noticed in the increase in productivity and income in adopted and non-adopted villages. The net income of marginal farmers increased the most amongst the different categories of farmers during the period of study. The field crops, horticultural crops and livestock contributed more to total additional income. To sustain the growth in productivity and consequent income of the farmers the Government can strengthen mechanism for continuous infusion of improved technologies and management practices in developmental programmes along with incentives to the farmers for quality seed and planting materials and matching critical inputs through a Misson-mode approach, more so in disadvantaged and challenged ecologies.

Keywords: Household, Interventions, Income, Productivity

Agriculture is amongst the major source of livelihood and a key sector of Indian economy contributing about 17.1% of the country's gross value added (GVA) and provides livelihood support to about 70 % of rural households in India (Balkrishna *et al.* 2021). Besides, sector is also employing about 50% workforce of the country. The income from agricultural and allied sector grew at 4.4% per annum during 2017–18 to 2022–23 (MoAFW 2023), one amongst the fastest growing sector. However, the per capita income in agriculture has been low compared to other sectors which is the major concern. Several initiatives and technological interventions have been adopted in recent times to enhance the income and socio-economic conditions of the farmers. Development and deployment of new technologies in farming have resulted into positive impacts for overall improvement in farm sector's economy. One of the positive implications of technological interventions has been an increase in the income of farmers who adopt them. Many stakeholders are responsible for taking these interventions to farmers leading to socio-economic improvement of farm households. It is noteworthy that the adoption of modern/advanced technology in agriculture sector improve the income of the farmers especially of small and marginal through enhanced agricultural productivity and quality. The quantified evidence of impact of technology interventions on farmers' household has been a matter of research for appropriate and evidence based policy decisions. The impact assessment of agricultural technology is also important for sustainable development of the sector and the society with its multiple interests and objectives (Rodrigues *et al.* 2003). The frontline extension institutions at district level under the overall governance of Indian Council of Agricultural Research have played a catalytic role in augmenting farmers income and development of rural economy. In order to generate the evidence of technological impacts in augmenting the income of the farmers in one of the most productive regions of the country, a study was carried out involving 640 farmers in 32 villages of Haryana. The impact of KVK

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interventions were measured through gain in productivity and income in 2020–21 over the baseline of 2016–17.

MATERIALS AND METHODS

Study area: This study was carried out during 2016–17 to 2020–21 in 8 districts of Haryana, viz. Ambala, Faridabad, Gurugram, Hisar, Kaithal, Mahendergarh, Rewari, and Yamunanagar which fall under Trans-Gangetic Plains agro-climatic region as categorized by the erstwhile Planning Commission of Government of India. In each district, four villages, two each under adopted and non-adopted category, were selected for the data collection. Cereal-cereal is the predominant cropping pattern in these districts with rice-wheat, cotton-wheat, pearl millet-mustard being the major cropping systems. The diversification towards low water demanding crops in the state is a stated policy of the Government. The climate of the districts is characterized by hot summers, moderate winters, and moderate rainfall during the S-W monsoon. The alluvial soil of this region is highly suitable for agriculture and supports a variety of crops. The region is settled with one of the highest cropping intensity in the country due to multiple cropping. This region also has high population density with agriculture being the primary occupation of the majority. Rural livelihoods in the region is supported by activities such as animal husbandry, dairy farming, agro-processing industries, and rural handicrafts.

Sampling: The primary data were collected from farmers of adopted villages and non-adopted villages. Multistage sampling methodology was applied for the section of villages. In the first stage, eight districts namely Ambala, Faridabad, Gurugram, Hisar, Kaithal, Mahendragarh, Rewari and Yamunanagar were selected randomly. In the second stage, purposive selection for adopted and non-adopted villages was done, and two adopted villages and two non-adopted villages of each KVKs, comprising of 32 villages, were selected. In the third stage, 20 respondent farmers from each adopted and non-adopted villages were selected randomly. The respondent's sample size of the villages varied proportionally according to the technology users/ adopters in case of adopted village and accordingly crop/ component/ interventions undertaken in case of non-adopted villages in the districts.

Method of data collection: The structured interview schedule was developed, and primary data were collected in person through face-to-face interviews on memory recall basis during 2020–21, with the involvement of selected KVKs.

Methods of data analyses: The quantitative data and concept of pre and post intervention analysis was adopted. Descriptive statistics were used to draw the inference from the data, and estimate the impact of technological intervention on the cumulative sampled households. The statistics, such as mean and percentage, were helpful in developing summary from quantitative data pertaining to production, productivity, net income, etc. of sampled household.

The extension gap has been calculated following Singh and Sharma (2017) as Extension gap = Yield obtained with KVK Interventions - Yield obtained with farmers practice Yield (non-intervention yield).

Technological interventions: Several technological interventions were implemented directly at farmers' field in adopted villages. These interventions, detailed in the accompanying table available in the journal's online materials, encompassed a range of recommended strategies which included the promotion of hybrid varieties of various field crops like rice, wheat, pulses, oilseeds and commercial crops. Integrated crop management protocols for each crop were recommended to the farmers for enhancing their income by augmenting crop productivity without deteriorating soil health. The farmers were also encouraged to diversify their agricultural activities by incorporating other enterprises such as fruit plantations, vegetables, spices and flowers cultivation and livestock rearing. Supplementary enterprises like mushroom cultivation, vermicomposting, and beekeeping were also promoted among farmers. To ensure optimal outcomes, scientific packages of practices were provided to farmers for all recommended enterprises, to maximize returns on their investments.

RESULTS AND DISCUSSION

The income of the farmers can be increased generally in three ways first through increasing the gross income, second through reducing the costs and third by higher price realization. Gross income can be increased by enhancing yield of crops and commodities, diversification into various farm and non-farm activities, area expansion in crops, and increasing number of livestock. Cost can be reduced through descending to natural ways of farming like organic farming, natural farming, better and integrated nutrient and pest's management of crops and livestock, implementing and resorting to input saving technologies, increasing input use efficiency. Income can be stabilized through water and other input saving methods and technologies, crop and asset insurances, traditional coping mechanism, government subsidy/support, etc.

Socio-economic characteristics of technology user and non-user were also recorded. About 48.75% farmers were more than 45 years of age in adopted, and non-adopted villages. A wide variation was observed in educational status of the respondents. Majority of technology user and non-user respondents were educated and only 18.75 and 26.56% were illiterate. Maximum number of respondents in both the villages were marginal landholders, representing about 66 and 68% of households surveyed. Pachiyappan *et al.* (2022) while studying demographical behaviour of protected and open field cultivators of horticultural crops also observed dominance of marginal and small landholders. The crop profile and livestock population varied in adopted and non-adopted villages. More crops in pulses, oilseeds, fruits and vegetables were grown in adopted villages as compared to non-adopted villages. The highest number of 13 vegetable crops were cultivated by farmers in adopted villages as compared to only 6 crops in non-adopted villages

reflecting thereby more diversified cropping portfolio in adopted village farmers than non-adopted village farmers. The respondents of adopted villages reared 50% higher dairy animals than non-adopted village farmers.

Extension gap analysis: During the period of study, emphasis was given to educate the farmers through various technologies for adoption of scientific technologies and practices in agriculture and allied sectors. The extension gap between demonstrated technology and farmer's practices ranged from -0.11 to 97.22 q/ha in field crops, 58.96 to 459.10 q/ha in horticultural crops, and 218.14 litre/lactation in dairy animals. The positive gap was due to adoption of technology disseminated by frontline extension system which resulted in increasing the yield of technology adopter farmers than the non-adopter farmers. The latest technology gradually leads the farmers to discontinue the old technology and to adopt new technology. The results indicated that farm household that owned more livestock operated relatively large plots of land and participated in various capacity development programmes. Zingiro *et al.* (2014) found better participation of large asset endowments farmers in farmers' organizations among others and adoption of rain water harvesting technologies to improve agricultural production and income. The endowment of farm assets positively influenced the decision to adopt system of rice intensification in India (Rosenballm 1985). The results also conform to the studies and analysis conducted under varying situations by Goswami *et al.* (1996), Hiremath and Nagaraju (2010) and Shukla *et al.* (2022). The extension gaps indicate the high acceptance of technologies and also offer an opportunity to educate and motivate farmers for adoption of new technologies. Adekunle (2013) identified agriculture extension as one of the most crucial and critical means to reach farm households in the rural areas. Sharafat *et al*. (2012) established that extension starts with knowledge management and ends with human enrichment.

Increase in cropping area: The positive impact of technological intervention caused higher area coverage, introduction of new crops and increase in numbers of animals in adopted and non-adopted villages with varying degrees in 2020–21 over 2016–17 (Table 1). While cereals recorded a decline in area in adopted and non-adopted villages, the pulses, vegetables recorded promising increase of 173.69 and 270.0% in adopted villages and 41.89% in oilseeds and 279.91% in vegetables over non-adopted villages. The cattle population grew by 95.76% and buffalo by 59.82% in adopted villages as compared to the growth of 12.20 and 21.46% in non-adopted villages. The increase in cropped area under pulses was 184.86%, and 279.91% in vegetables in adopted villages over non-adopted villages in 2020–21. The farmers were convinced by the positive impact of HYVs of field crops and horticultural crops as well as better breeds of animals which helped by augmenting their income. Besides, they were also incentivized with quality inputs for better cropping and higher productivity. To multiply their income, they augmented the cropped area as well as size of animal herds which ultimately worked as a multiplier of their income. Chander (2015) produced an evidenced based impact of training of farmers on adoption of improved technologies related to agriculture and allied sectors and consequent increase in crop production and improved farm income.

Increase in productivity of crops and livestock: Productivity is directly and positively proportionated to increasing the income of farmers. Adoption of high-yielding variety/breed, integrated nutrient and pest management, recommended agronomic/rearing practices, integrated farming, etc., help bridging yield gap and maximize aggregate income. The gain in productivity through technological intervention of agriculture and allied sectors (Table 2) revealed that the highest increase in productivity of 28.25% was noticed in oilseeds amongst food grains

Table 1 Increase in area (ha) and number of crops and animals due to technology interventions in adopted and non-adopted villages (n = 640)

		Adopted village area (ha)/number			Non-adopted village area (ha)/number			Per cent change over non-adopted village	
		2016–17	2020–21	Per cent change	2016-17	2020–21	Per cent change	2016–17	2020–21
Field crops	Cereals	962.01	832.20	-13.49	915.30	874.61	-4.45	5.10	-4.85
	Pulses	55.35	151.49	173.69	60.55	53.18	-12.17	-8.59	184.86
	Oil seeds	234.51	316.12	34.80	192.91	222.79	15.49	21.56	41.89
	Cash crops	195.03	224.78	15.25	162.06	177.28	9.39	20.34	26.79
	Forage	7.50	16.40	118.67	21.30	21.90	2.82	-64.79	-25.11
Horticulture crops	Vegetable	23.00	85.10	270.00	10.20	22.40	119.61	125.49	279.91
	Fruits	0.00	5.00	100.00	0.00	0.00	0.00	0.00	100.00
	Flowers	0.00	14.80	100.00	0.00	0.00	0.00	0.00	100.00
	Spices	0.00	8.60	100.00	0.00	0.00	0.00	0.00	100.00
Livestock	Cattle	165.00	323.00	95.76	205.00	230.00	12.20	-19.51	40.43
	Buffalo	443.00	708.00	59.82	438.00	532.00	21.46	1.14	33.08

followed by 18.33% in cereals in adopted villages. Amongst horticultural crops, fruits, flowers and spices were new introduction resulting in 100% increase in productivity. In livestock, the milk productivity in cattle increased by 23.43% compared to 13.19% in buffaloes (Table 2). Compared to non-adopted villages, the gain in productivity was much higher in cereals and oilseeds during base as well as terminal years of the study. It was due to introduction of improved and high yielding crop and varieties besides adoption of improved agro-techniques by the farmers in adopted villages. The gain in milk production was due to adoption of good management practices for feed, fodder, health and shelter including green fodder, mineral mixture and azolla and deworming. Comparatively more increment in yield in both crops and livestock was observed in adopted villages. The higher increment in yield in adopted villages over non-adopted villages was due to adoption of technological intervention at the respondent's fields as well as due to reduction in extension gap in improved varities and breeds and scientific management practices in adopted villages. The productivity gain was the highest in horticultural crops (72%) owing to use of high-yielding varieties and integrated crop management practices. Rastogi *et al*. (2022) reported 1.35 to 2 times higher productivity in lentils with the use of quality inputs and new improved seeds.

Investment in cropping and livestock rearing by farmers: During 2016–17 to 2020–21, the farmers in adopted and non-adopted villages invested differentially in agricultural activities with significant inter and intra variation. Amongst crops, horticulture attracted major investment compared to field crops and cattle amongst livestock in adopted as well as non-adopted farmers. The farmers in non-adopted villages invested positively in subsidiary enterprises as compared to 63.44% less by farmers of adopted villages (Table 3). The cost of cultivation increased positively by 110.24% in adopted villages and 50.36% in non-adopted villages in field crops. The increase in income from field crops was due to increase higher productivity owing to better technologies and management in 2020–21 compared to 2016–17. Comparatively higher minimum support price (MSP) of field crops like rice and wheat in 2021 over 2016–17, and assured procurement by food corporation of India and state Government due to implementation of MSP operations in Haryana also encouraged farmers to invest more in crop production. Compared to this, the net income from horticultural crops registered a negative growth particularly due to lower prices of vegetables in the market and no price support mechanism in place for vegetables. The return from cattle and buffalo were positive and over 100% increase in adopted villages against negative in non-adopted village in cattle but positive in buffalo. Comparatively better feed and fodder and health management in adopted villages proved advantageous for attracting more investment in livestock and consequent higher productivity.

Income from farm and non-farm sources: Various economic factors, including land size, livestock ownership, subsidiary enterprises, non-farm income, conservation practices, and asset values, contribute to differences in income. Table 4 illustrates the contrast in income between technology users in adopted villages and non-users in non-adopted villages across these economic variables. Among the intervention undertaken in different agriculture and allied sector, the highest of 208.08% net income of the household was with supplementary enterprises followed by 190.10% with horticulture, 171.29% with livestock and 114.57% with field crops over the base year in adopted villages. The increase in income in non-adopted villages for corresponding sectors was 100, -3.98, 87.65 and 51.74%, respectively. The non-farm income showed a negative growth throughout the study. The obvious reasons for the income increase in adopted villages were reduction of extension gap with implementation of technological intervention at the respondent's fields by frontline extension agencies of the districts. The probable reasons for increase in income of the farmers could be the adoption of technologies implemented by the KVKs which reduces the cost of crop

Table 2 Productivity gains due to technology interventions in adopted and non-adopted villages (n = 640)

Crop/Livestock		Adopted village productivity (q/ha)			Non-adopted village productivity (q/ha)			Per cent change over non-adopted village	
		2016–17	2020–21	% Change	2016–17	2020–21	% Change	2016–17	2020–21
Field crops	Cereals	41.36	48.94	18.33	39.39	43.40	10.18	5.00	12.76
	Pulses	8.99	10.41	15.80	10.50	10.52	0.19	-14.38	-1.05
	Oil seeds	17.10	21.93	28.25	16.88	19.87	17.71	1.30	10.37
	Cash crops	374.42	349.67	-6.61	258.26	292.65	13.32	44.98	19.48
Horticulture crops	Vegetable	315.06	249.55	-20.79	194.39	190.59	-1.95	62.08	30.94
	Fruits	0.00	459.10	100.00	0.00	0.00	0.00	0.00	0.00
	Flowers	0.00	209.13	100.00	0.00	0.00	0.00	0.00	0.00
	Spices	0.00	70.80	100.00	0.00	0.00	0.00	0.00	0.00
Livestock	Cattle	2041.69	2519.97	23.43	1990.11	2160.73	8.57	2.59	16.63
	Buffalo	2412.00	2730.16	13.19	2431.23	2563.09	5.42	-0.79	6.52

Table 3 Investment and income in cropping and livestock rearing (n = 640)

Crops/Livestock	Average Cost of cultivation/Rearing per farmer (₹)						Per cent change over non-adopted village	
	Adopted village			Non-adopted village				
	2016–17	2020–21	Per cent change	2016–17	2020–21	Per cent change	2016–17	2020–21
Field crops	171677	205963	19.97	197963	263049	32.88	-13.28	-21.70
Horticulture crops	54763	124490	127.32	37942	57940	52.71	44.33	114.86
Forage crops	6689	13653	104.10	10938	12271	12.18	-38.84	11.27
Subsidiary enterprises	177458	64876	-63.44	0	12450	100.00	100.00	421.09
Livestock	105764	202441	91.41	128778	185973	44.41	-17.87	8.86
Net income								
Field crops	149704	314739	110.24	110921	166779	50.36	34.96	88.72
Horticulture crops	280952	217728	-22.50	194856	187098	-3.98	44.18	16.37
Forage crops	18188	37868	108.20	34162	67286	96.96	-46.76	-43.72
Subsidiary enterprises	232060	61593	-73.46	0	25600	100.00	100.00	140.60
Livestock	115031	281898	145.06	100583	164564	63.61	14.36	71.30

cultivation and livestock rearing and improves the yield of the crop and commodities. The technology which can reduce the cost and improves the yield of the crop/commodities thereby increase in income are use of quality seed, healthy seedling, improved variety/ breed, less incidence of pests and diseases, regulation of growth and development utilization of resources such as land, soil, fertilizer, pesticides, post-harvest management, organized market, etc. The results are in line with the study conducted by Pralhakar (2013) in this impact study of protracted cultivation. Asrers *et al.* (2013) reported 6% and 18% increase in household income through participation in extension programmes.

Income by size of holdings: The impact of technological intervention on income of respondent's household of different land classes is presented in Table 5. Farmers of all the land classes benefitted from the technological intervention and it is noticed that the income of all types of land holding has increased during 2020–21 in the adopted villages of the region by more than two times with maximum of 148% of small farmers over the 2016–17. It is noticed that income of small farmers increased by 2.48 times, the highest for all classes, may be because of lower benchmark level. Likewise, income of marginal, medium and large land holders increased by 2.00, 2.14 and 2.00 times, respectively in adopted villages. The income of different categories of farmers increased in non-adopted villages also, albeit with less than the double. The increase in income in non-adopted village ranged from 53% of small farmers to 76% at large farm holdings. The possible reason could be utilization of existing land effectively by small holders. This also signifies those technological interventions played pivotal role in increasing the income of various agriculture and allied sectors of the farmers in adopted villages during 2016–17 to 2020–21. Birthal *et al.* (2014) and Mula and Sarker (2013) also found increase in farm income, especially of small and marginal holders with technological interventions and diversification in agriculture. Prabhakar *et al.* (2017) also noticed similar results in case of protected cultivation.

Total household income and employment: Both farm and non-farm income increased during 2016–17 to 2020–21 but more in adopted villages as compared to non-adopted villages. The increase in farm income in adopted villages was 144.04% against 69.56% in non-adopted villages and that in non-farm were -35.28 and 40.37%, respectively. The employment in farming grew marginally by 12.88% in adopted villages and 4.5% in non-adopted villages (Table 6). However, employment growth from non-farm sector was almost twice of farm sector in adopted villages but one-third of the farm sector in non-adopted villages. Overall growth in household income was 143.56% in adopted villages and

Table 4 Impact of technology interventions on income of respondent (n = 640)

Source of income	Adopted village		Per cent change	Non-adopted village		Per cent change	Per cent change over adopted village	
	2016–17	2020–21		2016–17	2020–21		2016–17	2020–21
Field crops	150502	322932	114.57	113377	172035	51.74	32.74	87.71
Horticulture	22868	66358	190.10	194856	187099	-3.98	-88.26	-64.53
Livestock	97416	264279	171.29	77622	145654	87.65	25.50	81.44
Subsidiary enterprises	2860	8809	208.08	0	25600	100.00	100.00	-65.59
Non-farm income	144471	93496.8	-35.28	171899	102509	-40.37	-15.96	-8.79

Table 5 Change in household income under different size groups in adopted and non- adopted villages (n = 640)

Category of farmers	Household no.	Share in total income (%)	Net income (₹/household at current prices)		Change in household income (%)
			2016–17	2020–21	
Adopted villages					
Landless	1	0.31	1202000	2340000	95
Marginal	213	66.56	468707	936610	100
Small	45	14.06	510564	1265688	148
Medium	44	13.75	668022	1427228	114
Large	17	5.31	857949	1715231	100
Total	320	100.00	-	-	-
Non-adopted villages					
Landless	0	0.00	0	0	0
Marginal	220	68.75	521757	796780	53
Small	60	18.75	358868	547254	53
Medium	30	9.38	450929	949053	111
Large	10	3.13	830729	1456723	76
Total	320	100.00	-	-	-

Table 6 Household income and employment in adopted and non-adopted villages (n = 640)

Source of income	Village	Year	Income (₹/Household)	Employment (Man-days/household)
Farm income/ Family	Adopted village	2016–17	273176.6	247.23
		2020–21	661370.51	279.07
	Per cent change		142.10	12.88
	Non-adopted village	2016–17	201350.4	239.94
		2020–21	339483.54	250.74
	Per cent change		68.60	4.50
Per cent change over non adopted village		2016–17	35.67	3.04
		2020–21	94.82	11.30
Non-farm income/Hired	Adopted village	2016–17	36290.03	113.28
		2020–21	92371.75	143.5
	Per cent change		154.54	26.68
	Non-adopted village	2016–17	44049.13	94.66
		2020–21	102509.1	95.7
	Per cent change		132.72	1.10
Per cent change over non-adopted village		2016–17	-17.61	19.67
		2020–21	-9.89	49.95
Total HH income/Total employment generation	Adopted village	2016–17	309467	360.39
		2020–21	753743	436.72
	Per cent change		143.56	21.18
	Non-adopted village	2016–17	245400	334.63
		2020–21	441993	342.34
	Per cent change	Per cent change	80.11	2.30
Per cent change over non-adopted village		2016–17	26.11	7.70
		2020–21	70.53	27.57

80.11% in non-adopted villages in 2020–21 over 2016–17. The total employment grew by 21.18 and 2.3% in adopted and non-adopted villages, respectively in 2020–21 compared to 2016–17. The higher income from farming in the adopted villages was due to enhanced productivity due to higher investment in quality inputs and improved technologies as evidenced from higher cost of cultivation in adopted villages. Apart from adoption of improved variety/ breed and management practices, agricultural diversification towards high value crops, commodities and livestock also helped in income and employment augmentation in adopted villages. Birthal *et al.* (2007) also found diversification and technological intervention as the potential tools for increase in farm income, especially for small and marginal holders. Birthal *et al*. (2014) further reported technology as the most important source of agricultural growth while diversification emerging as a sustainable source of growth. Mula and Sarker (2013) found resource conservation technologies, varietal replacement, new cropping rotations, integrated farming system, crop diversification and scientific management of livestock as key drivers for higher production, productivity and employment generation even in the disadvantaged areas which can uplift the socio-economic status of rural poor and sustain food and nutritional security.

Conclusion and policy implications

It can be inferred that the various technological intervention undertaken in the fields of agriculture, horticulture, livestock and ancillary enterprises have enabled farmers to enhance their farm income through increase in production and productivity, diversification and intensification of cropping and livestock management pattern of farming system, enhancement in value of the produce and commodities and involvement in subsidiary farm enterprise. The income of small farmers increased by 2.48 times and that of marginal, medium and large landholders by 2.00, 2.14 and 2.00 times, respectively with the technological intervention by frontline extension institutions and agencies. The growth in employment by 1.21 times in adopted villages also signifies the positive role of extension system in motivating farmers to engage better in diversified employment and income augmenting on-farm and off-farm activities.

While field crops income enhanced sustainably because of assured implementation of MSP, the diversification drive towards vegetables, horticulture and livestock experiences mixed response due to price shocks which needs to be addressed with transparent price discovery mechanism and its realisation. The farmers can be incentivised for processing and value addition of these perishables to reduce the post-harvest losses and sustain the diversification and avoid reverse switching over to field crops. A mission-mode drive for promotion of short-duration pulses in summer season is envisaged to augment the pulses production and improve soil health. The notable improvement in employment rates in adopted villages further supports the effectiveness of the extension system in promoting diversified on-farm and off-farm activities. It is recommended to allocate resources towards sustaining and scaling up these efforts to ensure continued benefits for farmers and their communities. Further augmentation of frontline extension system can also be supported with adequate human and financial resources to accelerate the pace and quantum of efforts towards sustainable agricultural development and strengthening the farmers' livelihoods.

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