Research Article

Indian Journal of Extension Education
Vol. 61, No. 2 (April–June), 2025, (19-24)

ISSN 0537-1996 (Print)
ISSN 2454-552X (Online)

Breaking the Barriers of Farm Income through Supplementary Enterprises: A Step beyond Farming Systems

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HIGHLIGHTS

- Households involved with the technological interventions by the Krishi Vigyan Kendras could achieve higher income faster than the control households.
- Horticulture components contributed to the bulk of the household income and technology adoption hastened the income earning process from horticulture.
- Initiation into supplementary enterprises has showed the way forward for rapid strides in income generation opportunities for rural households.

ARTICLE INFO

Keywords: Household income, Secondary agriculture, Agri enterprises, Technology uptake, Propensity matching.

https://doi.org/10.48165/IJEE.2025.61204

Conflict of Interest: None

Research ethics statement(s):
Informed consent of the participants

ABSTRACT

The study was conducted in ten districts of Karnataka in which Krishi Vigyan Kendras (KVKs) have introduced improved agricultural technologies and practices in selected villages during 2022. The interventions aimed at enabling the farmers to realize higher income from farm and non-farm activities. Propensity Score Matching was used to overcome the bias in sampling of treated and control category households. The probit analysis was applied to study the factors influencing household income. Agriculture + Horticulture + Livestock and Agriculture + Livestock were the most practiced farming systems by treatment and control group farmers, respectively. Increase in average net income was noticed in both the categories of the farmers over the benchmark. However, the highest net income was achieved by the treatment group farmers practicing Agriculture + Horticulture + Livestock + Supplementary enterprises. The importance of technological interventions was particularly evident when the same combination of enterprises practiced by the control category could only fetch lesser income.

INTRODUCTION

India continues to be a rural economy, with 66 per cent of its population living in rural areas (World Bank, 2019) and agriculture remains the mainstay of livelihood as it employs 42.3 per cent population and contributes 18.2 per cent in the country's GDP at current prices (GOI, 2024). Karnataka accounts for 5.83 per cent of the total geographical area of the country and contributes 8.4 per cent (2023-24) to the country's GDP. The share of agriculture, horticulture, animal husbandry and fisheries sectors in Karnataka GSDP is 13.04, 4.88, 3.78 & 0.57 per cent, respectively (GOK, 2024). Globally, farm income has been a policy concern, as the income gap between the agricultural and non-agricultural sectors as well as within the agriculture sector is widening (Vatta & Budhiraja, 2020). The average monthly income per agriculture household during 2018-19 was Rs. 10,218 (NSO, 2021) and a farmer earns only 20 per cent of the national per capita income (Birthal et al., 2017). Increased agricultural productivity aids in addressing low income and food insecurity but its success largely relies on technology uptake and utilization (GOI, 2018; Damba et al. 2020). Technology

Received 23-01-2025; Accepted 12-02-2025

uptake and adoption by farmers is mainly influenced by access to technological information *viz*., frequency, usefulness and perception; trust in the information sources, experience with similar innovation and financial status (Ghadim & Pannell, 1999; IFAD, 2009; Abate et al., 2011; Toma, et al., 2018). Therefore, it is essential to create a suitable condition for the innovation usage to harness its fullest potential (Bayissa, 2015; Nain et al., 2024). Farmers are increasingly favouring commercial crops like oilseeds and fruits/vegetables over traditional food grains, reflecting a response to market demands and profit maximization (Majhi & Kumar, 2018; Gulati & Juneja, 2022). Agri-business and/or enterprises can change the lives of farmers (Bayissa, 2015) by generating higher revenue. Adoption of improved agricultural technologies, high value farming, and crop diversification scale-up the farm income (Tesfaye et al., 2016; Fan & Rue, 2020; Basantaray et al., 2023).

In order to enable farmers to harness the power of technologies in the entire array of agriculture, horticulture, livestock, fisheries and supplementary enterprises, Krishi Vigyan Kendras (KVKs) promoted technology-driven income enhancement strategies. Technology introduction through various mechanisms contributed to increased productivity as the first level of output, which encouraged farmers to reduce the area under less profitable food crops for growing new crops (diversification) and/or expanding the scale of operation (intensification). The additional revenue generated from diversification and intensification encouraged the farmers to venture into farm and non-farm enterprises. Transformation of farmers as agri-business entrepreneurs through farm and non-farm enterprises has been a new beginning (Chandre Gowda et al., 2023; 2024). It is important for the development agencies to understand the transformative processes happening in the rural areas. Hence an attempt was made to understand the composition and changes in income of farmers adopting diverse farming system combinations promoted and supported by KVKs to increase and sustain farm income.

METHODOLOGY

The study was carried out in ten districts of Karnataka namely Belagavi, Bidar, Chamarajanagara, Davanagere, Gadag, Hassan, Kalaburgi, Kodagu, Kolar and Udupi during the year 2022. The KVKs in these districts introduced improved agricultural technologies and practices with an aim to enable farmers achieve higher income from farm and non-farm activities. From among such villages, two villages were randomly considered to study the impact of the interventions on household income. Data from 400 farm families, at the rate of 20 households each in 20 treated villages, were collected. Eighty-four data sets had missing data and were deleted limiting the sample size to 316 households. For each of the treated village, one non-treated village was identified randomly to serve as the control. Similar to that of treated, data from 400 farm families in the 20 non-treated villages were elicited. Forty-five data sets were incomplete and were discarded and the sample size from non-treated villages was 355.

Propensity Score Matching (PSM) was employed to overcome the bias in sampling. Each treated household was matched with control household based on the observable covariates age, education, gender, family size, family structure, type of dwelling, family members involved in farming, landholding, irrigation and farm machineries. The PSM can be expressed as given in the equation 1.

$$e_i = \Pr(D_i = 1 \mid X_i) \quad \ldots(1)$$

Where, e_i is a propensity score and Pr is the probability of being treated will receive the value for D_i is equal to '1' and '0' otherwise (control) conditional on the vector of covariates X_i. Probit model (equation 2) was employed to estimate the propensity scores (Greene, 2002).

$$\Pr(D = 1 \mid X) = G(z) = {}^{X'}\_{-\infty}{}^{\beta}\beta\phi\,(z)dZ = \varphi(X'\,\beta) \quad \ldots(2)$$

Where, $G(z)$ is a function taking values between 0 and 1, ϕ is the standard normal probability density function, z is the vector of covariates and φ is the standard normal cumulative distribution function.

The computed probabilities were used for matching treated and control categories through four matching algorithms (Mossie, 2022) viz., Nearest Neighbour Matching, Kernel-Based Matching, Radius Matching and Stratification Matching. Average Treatment Effect on the Treated (ATT) was computed which represents the effect of the treatment, using equation 3. ATT is,

$$\alpha = E\,[Y_i(1)] - E\,[Y_j(0)] \quad \ldots(3)$$

where, α = treatment effect, E(Y) = Expected income, 1= treated, 0 = untreated (control)
i = i^{th} farmer

The difference between Y_i, a randomly allocated member of the treatment group and Y_j, a randomly assigned member of the control group, shows the treatment effect.

RESULTS

The average age of the farmers was around 47 years in the treated households and 49 years in the control. Majority of them had higher secondary and secondary education. Only 5 per cent in the control households and 18 per cent in the treatment were female and the rest were male. But, comparatively more female farmers represented the treated households. The average family size of treatment and control farmers was 4 and 5, respectively. Further, around 64 per cent of the treatment and 69 per cent of control farmers lived in nuclear type families and majority (treatment 224 & control 288) of them stayed in pucca houses. In both the categories, on an average three members of a family were involved in farming activities and the average landholding was around 2 hectares. Majority of the treatment (68.35%) and control (72.96%) farmers cultivated under irrigated condition.

The households covered in the study followed various farming systems detailed in Table 1. Among the treated households, the number of farmers who practiced only agriculture or only horticulture got slightly reduced during 2020-21 compared to the benchmark year but livestock farmers increased comparatively during the same period. Further, among the various farming systems, Agri. + Horti. was the most followed farming system and Agri. + Horti. showed declining trend for the treated groups. Integrated farming system (Agri. + Horti. + Livestock) was followed by more than 75 treatment farmers during both the years. During 2020-21,

Table 1. Farming systems practiced by the treatment and control group farmers in the study area

Farming system	Treatment (n=316)		Control (n=355)	
	2016-17	2020-21	2016-17	2020-21
I. Mono farming				
Only Agriculture (A)	61	54	76	61
Only Horticulture (H)	41	37	23	27
Only Livestock (L)	29	32	21	24
II. Farming system				
A+H	45	44	58	58
A +L	32	27	97	99
H+L	28	28	10	15
III. Integrated farming system (IFS)				
A+H+L	77	76	61	67
IV. Beyond IFS (Supplementary enterprises)				
Supplementary enterprises (S)	0	1	0	0
A+S	0	0	0	1
H+S	0	1	0	0
L+S	0	0	1	1
A+H+S	0	1	0	0
A+L+S	0	0	2	1
H+L+S	0	4	0	0
A+H+L+S	0	11	0	1

beyond integrated farming system 11 treatment group farmers adopted Agri. + Horti. + Livestock + Supplementary enterprise system. Similarly, in the control category, agriculture only was the most practiced mono farming system and the number of farmers who practiced only agriculture got slightly reduced during 2020-21 and farmers' practicing only horticulture or only livestock increased to some extent. Among the farming systems (control group), Agri. + Livestock was the most followed farming system and the number of farmers practicing H+L and IFS increased during 2020-21 compared to 2016-17. More than three-fifth of the control group farmers followed integrated farming system in both the years (Agri. + Horti. + Livestock). Further, up to eighteen households in the treated category progressed beyond integrated farming towards entrepreneurship as against four households in the control category by the year 2020-21.

The details on the annual income of treatment and control households are given in Table 2. There was increase in income during 2020-21 compared to baseline year in both the category households. The average net income of the treated households nearly doubled from Rs. 2,74,207/HH (2016-17) to Rs. 5,18,183/HH (2020-21). During 2016-17, the treated households earned Rs. 1,00,000 more than control households, which was further increased to Rs. 2,59,111/HH during 2020-21, twice higher than control households. In the mono farming systems of treated category, horticulture farming fetched higher income (Rs. 7,01,213/HH), more than twice the income from agriculture (Rs. 3,01,771/HH) during 2020-21. With the technological interventions in horticulture, the additional income was to the tune of Rs. 3,23,327/HH over baseline year, as compared to Rs. 83,536/HH in the control group for the same period.

Among the farming systems having two components, Horti. + Livestock system fetched higher income (Rs. 7,87,589/HH) with technological interventions contributing an additional income of Rs. 3,76,631/HH over baseline year. In the control category Agri + Horti

Table 2. Net income from various farming systems practiced by the treatment and control group farmers in the study area

Farming system	Treatment (n=316)				Control (n=355)			
	Net income (Rs. /HH)			t value	Net income (Rs. /HH)			t value
	2016-17	2020-21	Change in income		2016-17	2020-21	Change in income	
I. Mono farming								
Only Agriculture (A)	116161	301771	185610	1.734*	78184	109851	31667	1.789*
Only Horticulture (H)	377886	701213	323327	1.600	70622	154157	83536	1.645*
Only Livestock (L)	48347	120588	72241	2.690**	37489	82669	45180	3.629**
II. Farming system								
A+H	331267	303149	-28118	0.256	327966	496487	168521	1.942*
A +L	115527	351814	236287	2.648**	136086	209853	73767	3.915**
H+L	410958	787589	376631	2.464**	250270	382835	132565	0.954
III. Integrated farming								
A+H+L	422826	672933	250107	1.858*	257064	345652	88589	2.452**
IV. Beyond IFS								
Supplementary enterprises (S)	-	615000	615000	-	-	-	-	-
A+S	-	-	-	-	-	154515	154515	-
H+S	-	484991	484991	-	-	-	-	-
L+S	-	-	-	-	252100	273600	21500	-
A+H+S	-	235400	235400	-	-	-	-	-
A+L+S	-	-	-	-	223250	100122	-123128	-
H+L+S	-	457295	457295	-	-	-	-	-
A+H+L+S	-	1673171	1673171	-	-	122004	122004	-
Average net income (Rs/HH)	274207	518183	243976		167488	259072	91584	

Note: ** & * indicates significance at one and five per cent level of probability

system fetched higher income (Rs. 4,96,487/HH) during 2020-21 an increase of Rs. 168521/HH over 2016-17. The Agri + Horti + Livestock integrated farming provided an income of Rs. 6,72,933/HH during 2020-21, an increase of Rs. 2,50,107 over 2016-17, which was comparatively higher than added income of the control category (Rs. 88589/HH). The impact of technological interventions was very much visible for the treated households which switched over to supplementary enterprises for the first time. The households that chose Agri. + Horti. + Livestock + Supplementary enterprise system generated a net income of Rs. 16,73,171/HH, which was the highest over all other farming systems practiced by treated as well as control categories. The importance of technological interventions was particularly evident when the same combination of enterprises practiced by the control category could only fetch Rs. 1,22,004/HH.

The share of income from various sources for control and treated households during 2020-21 is given in Figure 1. The treated households earned 60 per cent of their income from horticulture compared to 49 per cent in the control group. Cultivation of agricultural crops contributed to 35 per cent of the household income for control group as against only 19 per cent for the treated households. Treated households were comparatively less dependent on agricultural crops cultivation for income. There was not much difference in the share of livestock income for both the categories of households and it provided 15 to 16 per cent income for both categories of households. Most important is that the treated households received five per cent of their income from supplementary enterprises while the share of the same for control households was very meager, as little as one per cent. The supplementary enterprises carried out by control group farmers were vermicomposting and kitchen garden whereas treatment group farmers were involved in various enterprises like mushroom production, beekeeping, nursery, seri-compost production, RTF bag production, custom hiring service, drip irrigation retail enterprise and also vermicomposting. Enterprise participation could be region and category specific (Tiwari et al., 2023), which needs the attention of the policy makers.

The results of the probit regression is given in Table 3. The factors such as education and number of family members involved in farming have positive influence. More than 65 per cent of treated farmers have education beyond secondary level. This implied that farmers' education level increased the participation in technology uptake and hence has a significant contribution (Jatav, 2024). Whereas, gender, family size, family structure, type of dwelling and no of farm machineries owned has negative influence on participation in technology uptake. Gender has negative influence indicating that if the farmer is a female, then it is less likely that the farmer will participate in technology uptake. Family size has negative influence on participation in technology uptake, depicting that smaller households had better participation in technology uptake. Type of dwelling had negative influence on participation in technology uptake, indicating that poorer households had increased participation in technology interventions. With increase in no. of farm machineries, the farmers' participation in technology uptake decreased. All pointed to the facts that the educated small holders were more involved in technological interventions and harnessed the benefits of technology uptake better than their counterparts.

Table 3. Probit model for determinants of participation in technology uptake

Particulars	Coef.	Std. Err.	z	P>z
Constant	3.429	0.565	6.070	0.000
Age	0.002	0.005	0.330	0.739
Education	0.138***	0.029	4.770	0.000
Gender (Female-1, Male-2)	-1.482***	0.196	-7.560	0.000
Family size	-0.074*	0.038	-1.960	0.050
Family structure (Joint-1, Nuclear-2)	-0.357***	0.127	-2.810	0.005
Family members involved in farming	0.093*	0.049	1.890	0.058
Type of dwelling	-0.346***	0.127	-2.720	0.006
Landholding	0.038	0.033	1.150	0.249
Irrigation	-0.195	0.121	-1.610	0.108
Farm machineries	-0.490***	0.051	-9.680	0.000

ATT estimates were obtained from the analysis which indicated the difference between the household income of the treated and control households (Table 4). The results of PSM showed that the treated households received higher income compared to Non-treated households. The average treatment effect on treated (ATT) was found to be significant in all the methods. It was observed that the treated households earned an additional income ranging from

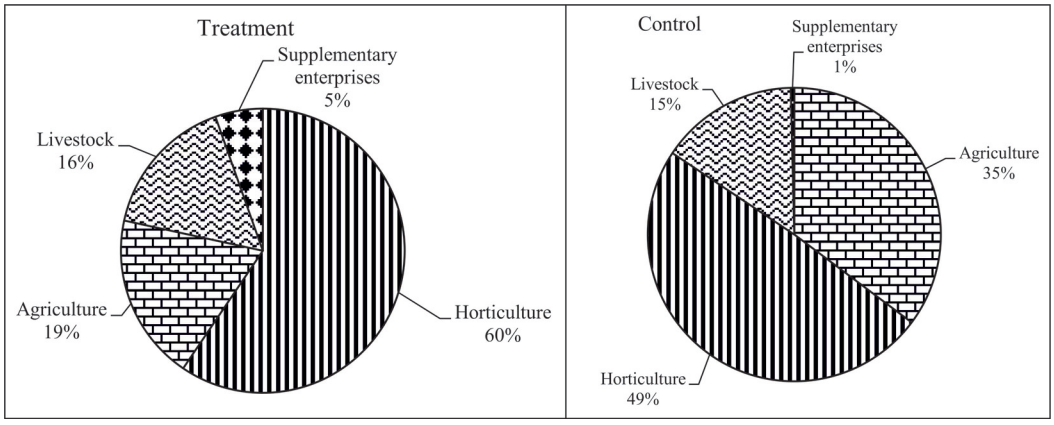

Figure 1. Share of income from various sources during 2020-21

Table 4. Impact estimates of technology uptake on household income of treated v/s control group

Matching methods	n. treat.	n. contr.	ATT	Std. Err.	t value
Nearest neighborhood (NN)	316	339	322747	63891.65	5.051
Kernel matching (KM)	316	339	305417	45803.20	6.668
Radius matching (RM)	316	339	300182	45871.13	6.544
Stratification	316	339	317326	42541.28	7.459

Rs. 3,00,182 to Rs. 3,22,747. The impact of KVK Interventions was clearly observed for the treatment group, which has higher income by Rs. 3,22,747 (NN). Thus, it can be clearly stated that KVK supported farm households earned more income than the control households.

DISCUSSION

Over the years (from 2016-17 to 2020-21), increase in the net income is noticed among both the treated and control group famers. The increase in income of the treated group farmers is attributed to increased productivity and reduction in cost of production. For example, in case of paddy cultivation, increase in productivity was 8.42 q/ha. Based on the average market price of Rs. 1231/q for the quantity produced by the farmers, the additional gross returns is Rs. 10369/ha. Even though there is an additional cost of Rs. 3625/ha, the net return is Rs. 6744/ha. Technology adoption further helps in lower production cost per unit (Rs. 56/q) which adds to the overall net income of the household. Likewise, in tomato cultivation, 203.29q/ha additional yield is achieved at an expense of additional Rs. 54047/ha, but at a reduction in unit cost of production (Rs. 53/q). This unit reduction in production cost per quintal results in additional overall net income of Rs.135544/ha. Thus the contribution of technology adoption is evident in multiple ways. Similar trend is noticed in other crops like maize, greengram, pigeonpea, groundnut, cotton, mango, chilli, onion, chrysanthemum, cardamom, black pepper, etc. Although there was not much change in the number of horticulture growers before and after, there is significant change in the share of income from horticulture among the treated households (60%), compared to control households, which is mainly attributed to technology uptake.

The t values for the households having livestock component like livestock alone, Agri + Livestock, Horti + Livestock, Agri + Horti + Livestock reveal significantly higher income over benchmark year compared to households without livestock component like Horticulture alone and Agri + Horti households. This is in line with the general trends about the growth rate and contribution of animal sector to agricultural GDP. The present study proved the importance of livestock in increased income during 2020-21 compared to benchmark year. The results are supported by Rajni & Walia (2016); Kumar et al., (2022); Seemakowsar & Gaddi (2024). The institutional and technological support provided by the KVKs was instrumental in encouraging the treated farm households to start supplementary enterprises, where none practiced any enterprises during 2016-17, but 18 households ventured into agri entrepreneurship during 2020-21. Within as well as between the treated and control category, the quantum of income contributed by supplementary enterprises is visibly superior to those households which did not take up entrepreneurship. This should augur well for the emerging importance for secondary agriculture, which demands farmers to progress from production oriented agriculture to beyond production, focusing on agri enterprises to boost income and sustainability of farming.

CONCLUSION

The emerging trend points towards farmers venturing into supplementary enterprises for realizing higher income. Need of the houris to sustain and scale up these supplementary enterprises through necessary policy and programmatic support. Horticulture constituted the major share of household income and share of agriculture is gradually decreasing. It puts the onus on the development departments and governments to strengthen the horticulture sector by addressing the bottleneck issues like storage facilities, supply and value chain strengthening, price monitoring and glut management. At the same time, it is crucial to address the collateral damages arising out of decreasing share of agriculture in household income. The issue of food security of the nation must always be handled carefully by ensuring the profitability for the food producers. The share of livestock in household income was almost same in both categories of farmers, which requires attention on the technological interventions that can enhance contribution from the livestock components in a farming system.

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