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Impact of Technological Interventions on Farmers Income through Enhanced Productivity, Intensification and Diversification in Southern Karnataka

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Abstract

The study presents a comprehensive analysis of the impact of technological interventions of Krishi Vigyan Kendras on farm productivity, intensification, diversification and income of farm households. A total of 1322 successful farmers in 11 districts of South Karnataka were purposively considered for the analysis. The productivity of crops and animals achieved by respondent farmers during 2021 were compared with their yields during benchmark year (2017) as well as the average of farmers in the study districts during 2021. The increase in productivity of agricultural crops was highest for greengram (73.20%) and groundnut (72.88%) over the benchmark year. The increase in productivity in horticultural crops ranged from 8.06 per cent in guava to 75.43 per cent in cashew over the benchmark year. The productivity levels achieved by KVK farmers due to interventions was more for all the crops when compared with the average productivity prevailing in the region except for papaya. Encouraged by higher productivity, about 22 per cent farmers decreased area under agricultural crops and used the same for intensification (55% farmers) and diversification (45% farmers) to horticultural crops. About 26 per cent of the farmers intensified livestock rearing as well. The increase in overall income was highest for farmers in Davanagere district. The diversity index values were positive for many districts with highest gain observed in Hassan district.

Keywords : Farmers income, Diversification, Productivity, Technological interventions, Horticulture

Technological interventions drive the productivity per unit of land and resources used, could simultaneously optimize the cost of production and thus offer a compounding effect in obtaining higher income for farmers. Increasing productivity per unit of land must be the main engine of growth, as almost every bit of cultivable land in India has already been put under cultivation (World Bank, 2012). Given the fact that technology uptake is low (Gulati *et al.,* 2021), upgradation to high-tech methods provide an effective avenue for increasing farm output, decreasing costs and thereby increasing farmer's income (Chand, 2019). While relevant technological interventions can help to increase productivity, it is just not enough to increase farmer's income. Farmers need to intensify the cropping and livestock activities to earn more per unit of land and other resources. Diversification in farm operations reduces the degree of specialization and the associated risks (Harkness *et al.,* 2021) and hence growth in livestock and supplementary sources are vital for overall farm household income (Ranganathan, 2015 and Yasmeen *et al.,* 2019). In order to enable farmers to harness the power of technologies in the entire gamut of agriculture, horticulture, livestock, fisheries and supplementary enterprises, Krishi Vigyan Kendras (KVK) across the country promoted technology-driven income enhancement strategies. This was in line with the national goal of doubling farmer's income as a sustainable measure to achieve farmers

welfare. The intensive efforts of the KVKs created many successful cases within a short span of time in each district of Karnataka. All the effects of these interventions are long-lasting and continuous. As a mid-term evaluation process, it was necessary to understand the technologies adopted by successful farmers and the extent of contribution of various components in increasing household income. Therefore, the study was aimed at ascertaining the extent of increase in productivity and its impact on intensification and diversification towards increasing farm income.

Methodology

The South Karnataka districts considered for the analysis include Bengaluru Rural, Chamarajanagara, Chitradurga, Chikkaballapura, Davanagere, Hassan, Kolar, Mandya, Mysore, Ramanagara and Tumakuru. To measure the impact of interventions, a total of 1322 successful farmers whose database was available with the KVKs in the given districts were purposively considered for the study. The aim of the present paper was to quantify the contribution of technology application on productivity driven intensification, diversification and income enhancement for the farm households. The change in productivity from 2017 to 2021 in major agricultural and horticultural crops and livestock was considered as the first step towards intensification (increasing the area, number of crops, number of livestock reared) and diversification (introducing a new crop, livestock, fisheries and/or supplementary enterprise). The productivity during the study year (2021) was compared with the productivity for the same farmer before interventions (2017) and also compared with the productivity for the same crop in the study districts, fetched from the secondary data (DES, 2021). The data was analysed with the help of simple averages, percentages and Simpson's Index of Diversity.

The extent of income source diversification was calculated using Simpson's Index of Diversity (SID) (Tiwari *et al.,* 2023), which is adapted and measured as:

$$SID = 1 - \sum_{t=1}^{n} \left[\left(\frac{AI}{THI}\right)^2 + \left(\frac{HI}{THI}\right)^2 + \left(\frac{LI}{THI}\right)^2 + \left(\frac{FI}{THI}\right)^2 + \left(\frac{SEI}{THI}\right)^2 \right]$$

where, *SID* - Simpson index of diversity; *AI* - Agricultural income; *HI* - Horticultural income; *LI* - Livestock income; *FI* - Fisheries income; S*EI* - Supplementary enterprises income and *THI* - Total household income. The value of SID ranges from zero (0) to one (1). The index's value towards zero indicates income from single source, while its value towards one indicates diversified source of income from all five components.

Results and Discussion

Change in Productivity

The results on the impact of technological interventions on productivity of agricultural crops are given in Table 1. The findings revealed that there was increase in productivity in all the crops for the KVK supported farmers. The highest increase in productivity during the study year (2021) over benchmark year (2017) was noticed for greengram (73.20%) and groundnut (72.88%), due to the technological interventions adopted by the farmers. Among cereals, the highest increase was observed in ragi (34.05%). During the year 2021, the average productivity with interventions was more when compared with the average productivity in the region. For example, the average yield of greengram in the region during 2021 was 1.35 q/acre compared to 4.55 q/acre for the farmers adopting the interventions, a difference of over 237 per cent. The increase in productivity could be attributed to new variety KKM-3 and adoption of integrated disease management practices. Past studies have reiterated the above results wherein significant growth in productivity was achieved through introduction of drought resistant and high yielding varieties (Bellundagi and Umesh, 2016).

The differences in productivity over the average yield levels in the region indicate the potential for increasing the productivity in most of the crops. The various

Table 1

Impact of interventions on productivity of agricultural crops

Crop	Respondent farmers'productivity (q/ac)		% Change over 2017	Productivity (q/ac)		% Difference over regional average
	2017	2021		Regional average 2021	Respondent farmers 2021	
Cereals						
Paddy	20.44	24.95	22.08	17.60	24.95	41.76
Maize	17.74	21.93	23.63	14.30	21.93	53.36
Ragi	8.88	11.91	34.05	6.97	11.91	70.88
Sorghum	5.30	6.93	30.91	5.77	6.93	20.10
Pulses						
Chickpea	4.20	6.00	42.85	2.44	6.00	145.90
Pigeonpea	4.58	7.47	63.06	2.57	7.47	190.66
Blackgram	1.88	3.17	69.20	2.09	3.17	51.67
Greengram	2.63	4.55	73.20	1.35	4.55	237.04
Oilseeds						
Groundnut	5.79	10.01	72.88	4.35	10.01	130.11
Soybean	4.00	5.05	26.25	4.82	5.05	4.77
Sunflower	3.12	4.26	36.54	4.35	9.66	122.07
Commercial crops						
Cotton	5.85	6.40	9.36	2.60	6.40	146.15

technological interventions adopted by the respondent farmers that contributed to increase in productivity and decrease in cost of cultivation are detailed below:

Cereals

- Introduction of improved varieties in paddy: Gangavathi Sona, KRH-4, KMP-220, KMP-99, KPR-1, MSN-99, RNR-15048, BR-2655, aerobic paddy-MAS-26 and Paustic-9, maize: MAH-14-5, ragi: ML-365, MR-6, KMR-630, KMR-316, KMR-340, KMR-301 and Indaf-7, sorghum: SPV-2217, COFS-29, COFS-31, DHN-6.
- Promotion of DSR and mechanized transplanting in paddy, assessment of paddy variety Gangavathi Sona for southern dry zone
- Promotion of maize + pigeonpea (6:1) intercropping system, integrated pest and disease management practices in maize (fall armyworm and leaf blight) and ragi (stem borer and neck blast), assessment of nano-fertilizers on growth and yield of maize and potassium management in maize through Bio-K.
- Seed production, ICM and value addition in ragi

Pulses

- Introduction of improved varieties in chickpea: JAKI-9218, JG-11, BGD-103, pigeonpea: BRG- 1, BRG- 2, BRG- 3, BRG -4, BRG-5, TS-3R, BSMR-736, blackgram: Rashmi, DBGV-5, LBG-791 and greengram: KKM-3

- Promotion of pigeonpea varieties suitable to terminal drought
- ICM in pigeonpea and chickpea
- Improved pulses production technologies such as use of pulse-magic and nipping
- Introduction of finger-millet, fieldbean, groundnut and cowpea as intercrops in pigeonpea
- Integrated pest and disease management practices in pigeonpea (pod borer, sterility mosaic and wilt) greengram (yellow mosaic) and chickpea (pod borer and wilt)

Oilseeds

- Introduction/promotion of high yielding varieties in groundnut: GPBD-4, G2-52, K-6, Dh-256, ICGV-03043, GKVK-5, KCG-6, GKVK-27, Kadri Lepakshi 1812, TAG-24, soybean: DSb-21 and sunflower: KBSH-5, KBSH -78
- Integrated pest and disease management practices in groundnut (thrips, red hairy caterpillar, collar rot and leaf minor) and sunflower (bud necrosis and downy mildew)
- Soil test based fertilizer recommendation in major agricultural crops *viz*., groundnut, maize, finger millet, chickpea and cotton
- Intercropping of groundnut with pigeonpea (8:2 ratio)

Commercial crops : Promotion of micro-nutrient and pest management in cotton.

Table 2 depicts the impact of interventions on productivity of horticultural crops. The results show

Table 2

Impact of interventions on productivity of horticultural crops

Crop	Respondent farmers'productivity (q/ac)		% Change over 2017	Productivity (q/ac)		% Difference over regional average
	2017	2021		Regional average 2021	Respondent farmers 2021	
Fruits						
Mango	46.96	64.95	38.31	20.94	64.95	210.17
Grapes	101.60	120.65	18.75	102.55	120.65	17.65
Guava	52.54	56.77	8.06	33.90	56.77	67.46
Papaya	174.00	232.60	33.68	263.71	232.60	-11.80
Pomegranate	39.10	64.58	65.17	48.95	64.58	31.93
Cashew	4.43	7.78	75.43	5.97	7.78	30.32
Vegetables						
Potato	73.91	98.50	33.28	55.16	98.50	78.57
Tomato	169.24	206.82	22.20	53.94	206.82	283.43
Onion/ White onion/ Rose onion	86.49	112.49	30.06	41.19	112.49	173.10
Beans/ French beans	55.67	64.90	16.57	43.74	64.90	48.38
Cabbage	112.96	128.08	13.38	126.97	128.08	0.87
Brinjal	88.09	113.85	29.24	45.23	113.85	151.71

that the interventions increased the productivity in all the fruits and vegetables. For the respondent farmers, the rise in productivity from 2017 to 2021 ranged from around eight per cent in guava to 75 per cent in cashew. In vegetables, the increase ranged from about 13 per cent in cabbage to 33 per cent in potato. The differences in the actual yield in the region and the respondent farmers showed large difference for all the fruits and vegetables except for papaya. For example, the average yield of mango in the region during 2021 was 20.94 q/acre whereas it was 64.95 q/acre for the farmers adopting the KVK interventions which indicated there was more than 200 per cent difference. Thus, it can be inferred that technological interventions helped the farmers to perform better with higher productivity and at the same time reduce the cost of cultivation. Some of the commonly adopted technological interventions are given below:

Fruits

- Mango-special for micro-nutrient management
- Pruning and canopy management along with good management practices in mango
- Integrated pest and disease management practices for management of bacterial blight, wilt, thrips and fruit sucking moth in pomegranate
- Soil test based nutrient management in pomegranate, grapes, papaya, mango, guava and onion
- Introduction of dryland horticulture crop cashewnut with varieties Ullal-3 and Vengurla
- Integrated crop management, water conservation by semi-circular basin around trunk, soil enrichment with green manuring as intercrop in dryland fruit orchards
- Quality planting material of major fruit crops from KVK nurseries

Vegetables

- Introduction of improved varieties in onion: Arka Kalyan, Arka Bheem, Bhima Shakti, Bhima super, Bhima Dark Red, tomato: Arka Rakshak, Arka Abhed, potato: Kufri Himalini, Frenchbean: Arka Arjun, Arka Suvidha, Arka Sharat
- Introduction of rose onion crop for export using Arka Bindu variety, foliar application of vegetable-special as micro-nutrient mixture, management of thrips, purple blotch and bulb rot
- Farmers participatory onion seed production and seed propagation of small onion variety Co-5
- Promotion of vegetable-special for micro-nutrient management in all vegetable crops
- Introduction of Apical Root Cuttings technology in potato
- Management of late blight in potato through integrated approach
- Gypsum and boron application, use of mechanical planter, sprayer and harvester in potato cultivation
- Fertigation in tomato to reduce cost of cultivation and increase yield
- Management of diamond back moth in cabbage, shoot and fruit borer in brinjal
- Frenchbean, as an intercrop in coconut garden.

Many farmers were able to reap rich dividends of the technological interventions with a difference in productivity levels over regional average. Similar impact of technological interventions have been reported by other researchers as well (Gunadal *et al.,* 2023).

The effect of technological interventions on productivity of livestock was also documented and is given in Table 3. Increase in productivity per lactation per animal was more than 400 litres in cows and more than 240 litres in buffaloes due to the interventions. The interventions promoted by the KVK's under livestock are indicated below.

- Fodder varieties : BNH-10, DHN-6, CoFS-29, CoFS-30, CoFS-31 Co-3, Co-4, Co-5
- Fodder seed production

TABLE 3

Impact of interventions on productivity of livestock

Particulars	2017	2021	% Change
Cow/cross bred/desi (litres/lactation)	1390.55	1793.37	28.97
Buffalo (litres/lactation)	786.63	1033.13	31.34

- Balanced nutrition, area-specific mineral mixture, azolla as feed supplement and clean milk production practices in dairy animals
- Cost efficient nutrient management with locally available and low cost mixtures such as ragi straw, millets, pulses and oilcake
- Animal health camps for vaccination
- Management of anestrus in heifers and infertility management in cross bred dairy cattle
- Management of high yielding dairy cow through supplementation of bypass fat
- Ration balancing technology, area specific mineral mixture for repeat breeders, deworming and vaccination protocols, mastitis and ecto parasites management.

Enhanced Productivity Helps in Intensification and Diversification

Motivated by the gain in productivity, respondent farmers explored multiple options to realize higher income. Continuing the prevailing cropping system with improved management practices was the first option that harnessed the productivity enabled income enhancement (Table 4). The next choice was to intensify the presently grown profitable crops by expanding the area or number of animals. This was more evident in the horticulture component, wherein 29.91 per cent of the farmers intensified the horticultural crops grown. This trend was also apparent for the livestock component, as about 26.27 per cent of the farmers increased the number of animals reared. Diversification through addition of new crops/activities was the third option, which was very much reflected for starting new livestock components (11.20%). New horticultural crops were taken up by 9.72 per cent of the farmers and 7.60 per cent of the farmers took up to supplementary enterprises which included mushroom production, beekeeping, vermicomposting, nursery, processing and value addition. The technology driven progression path included a gradual transformation from higher productivity to intensification, diversification and entrepreneurship development for achieving enhanced

TABLE 4

Options explored by farmers to enhance farm and household income

Options to increase farm income	No. of farmers			
	Agriculture	Horticulture	Livestock	Supplementary enterprises
Continue the prevailing system with improved management practices	848 (58.85)	820 (55.74)	904 (60.27)	1061 (73.99)
Intensification	163 (11.31)	440 (29.91)	394 (26.27)	257 (17.92)
Diversification	26 (1.80)	143 (9.72)	168 (11.20)	109 (7.60)
Decrease in area	311 (21.58)	62 (4.21)	24 (1.60)	4 (0.28)
Discontinuation	93 (6.45)	6 (0.21)	10 (0.67)	3 (0.21)

*Figures in parenthesis are percentage values

household income (Chandre Gowda *et al.,* 2024). High crop diversity indicated through crop diversification index was also reported by Felix and Ramappa (2023).

In order to intensify and diversify, farmers had to decrease area under agricultural food crops (21.58%) and about 6.45 per cent of the farmers stopped growing agricultural crops, as these crops were less profitable compared to horticulture and livestock components. Among 6.45 per cent of the farmers who discontinued the cultivation of agricultural crops, majority of them started cultivation of horticultural crops and were also involved in livestock and establishing supplementary enterprises. On the other hand, very few farmers discontinued cultivation of horticulture crops, livestock and enterprises.

Further analysis for the decrease in area of agriculture, horticulture and other components is given in Table 5. Among 311 farmers who reduced area under agricultural crops, 54.34 per cent of the farmers increased the area under existing horticultural crops (intensification) and 45.66 per cent of the farmers started cultivation of new horticultural crops (diversification). It was also noticed that 17.04 per cent of the farmers took up rearing of livestock and 15.43 per cent of the farmers started enterprises as a new activity, which were the indications of diversification. Around 11.57 per cent of the farmers strengthened livestock component by increasing the animal component. Those who decreased area under horticulture crops (62 farmers), 17.74 per cent of the farmers intensified the livestock component and 45.16 of the farmers started agriculture cash crops like cotton or sugarcane (28 farmers). Out of 24 farmers who reduced rearing of livestock, many of them started cultivation of horticultural crops with the technological support from KVKs. Udaykumar *et al*. (2020) reported that farmers diversified from food crops to vegetable and flower crops due to high value.

The extent of change in gross income from different sources in the study districts due to KVK interventions is presented in Table 6. Horticulture sector was the major contributor to the absolute increase in income over benchmark year, which was highest in Davanagere district (Rs.764917/household) and least

Table 5

Intensification and diversification as a result of increased productivity

Option adopted to increase farm and household income	Decreased area under agriculture (n=311)	Decreased area under horticulture crops (n=62)	Decrease in livestock (n=24)	Decrease in enterprises (n=4)
Intensification	Increased area under horticulture 169 (54.34)	Increased area under agriculture 28 (45.16)	Increased area under agriculture 2 (8.33)	Increased area under agriculture 2 (50.00)
	Increased livestock 36 (11.57)	Increased livestock 8 (12.90)	Increased area under horticulture 2 (8.33)	Increased area underhorticulture 2 (50.00)
Diversification	Started new horticulture crop 142 (45.66)	Started agriculture 14 (22.58)	Started agriculture 1 (4.17)	Started agriculture 0 (0)
	Started new livestock component 53 (17.04)	Started livestock 11 (17.74)	Started horticulture 10 (41.67)	Started horticulture 1 (25.00)
	Started an enterprise 48 (15.43)	Started an enterprise 8 (12.90)	Started an enterprise 2 (8.33)	Started livestock 0 (0)

*Figures in parenthesis are percentage values

TABLE 6

Component-wise income (Rs./household) and the level of diversification (SID) among farmers in different districts of South and Central Karnataka

Sources of Income	Year	Mandya	Mysore	Hassan	Tumakuru	Kolar	Chitradurga	Chamarajanagara	Bengaluru Rural	Ramanagara	Chikkaballapura	Davanagere
Agriculture	2017	150443	143014	55831	49595	35822	88914	87352	42130	39077	51405	196466
	2021	240379	228104	77784	87673	69451	138335	157769	42284	58459	52519	230045
	Change	89936	85090	21953	38078	33629	49421	70417	154	19382	1114	33579
	%	59.78	59.50	39.32	76.78	93.88	55.58	80.61	0.37	49.60	2.17	17.09
Horticulture	2017	148089	137411	237426	211829	276123	640076	327117	132027	226476	158634	386031
	2021	306776	320031	459081	438747	610800	1171307	627029	287683	466488	369177	1150948
	Change	158687	182620	221655	226918	334677	531231	299912	155656	240012	210543	764917
	%	107.16	132.90	93.36	107.12	121.21	82.99	91.68	117.90	105.98	132.72	198.15
Livestock	2017	6345	30052	0	76411	16044	55823	24990	12936	70737	21947	49677
	2021	54097	93241	5079	151431	72004	107627	42430	59563	162388	79135	114750
	Change	47752	63189	5079	75020	55960	51804	17440	46627	91651	57188	65073
	%	752.59	210.27	-	98.18	348.79	92.80	69.79	360.44	129.57	260.57	130.99
Fisheries	2017	0	0	0	0	0	0	0	0	0	59	0
	2021	0	0	187	0	0	0	0	0	851	164	5088
	Change	0	0	187	0	0	0	0	0	851	105	5088
	%	0	0	-	0	0	0	0	0	-	177.97	
Supplementary	2017	22200	31176	1324	7450	119019	22483	5427	0	40972	69893	256975
enterprises	2021	80800	107894	61153	41760	283599	47044	18764	405	90176	167198	1058655
	Change	58600	76718	59829	34310	164580	24561	13337	405	49204	97305	801680
	%	263.96	246.08	4518.81	460.54	138.28	109.24	245.75	-	120.09	139.22	311.97
Total	2017	327077	341653	294581	345285	447008	807296	444886	187093	377262	301938	889149
	2021	682052	749270	603284	719611	1035854	1464313	845992	389935	778362	668193	2559486
	Change	354975	407617	308703	374326	588846	657017	401106	202842	401100	366255	1670337
	%	108.53	119.31	104.79	108.41	131.73	81.38	90.16	108.42	106.32	121.30	187.86
SID	2017	0.578	0.647	0.314	0.554	0.54	0.354	0.418	0.447	0.582	0.636	0.676
	2021	0.653	0.689	0.394	0.566	0.568	0.345	0.413	0.421	0.578	0.612	0.617
	Change	0.075	0.042	0.080	0.012	0.028	-0.009	-0.005	-0.026	-0.004	-0.024	-0.059

in Bengaluru Rural district (Rs.155656/household). Compared to other sectors, increase in income from agricultural crops was not much, which was highest in Kolar district (93.88%) and least in Bengaluru Rural district (0.37%). The increase in gross income from livestock component was more in Mandya district (maximum of 752.59%) followed by Bengaluru Rural district (360.44%) and Kolar district (348.79%). Supplementary enterprise is a sunrise sector as evident from more than 100 per cent increase in additional income in most of the districts over the benchmark year and the added income was high in Davanagere district to the extent of Rs.801680/household.

Higher index of diversity (SID values) during the year 2021 was recorded for Mysore district (0.689) and Mandya district (0.653). Increased diversity (SID values) over benchmark year was evident for Hassan (+0.080), Mandya (+0.075), Mysore (+0.042), Kolar (+0.028) and Tumakuru districts (+0.012) and its impact on income was also evident with an overall increase in income of more than 100 per cent over benchmark year in all these districts. Vanitha and Reddy (2020) reported correlation between higher annual income and diversification. Kumar and Gajanana (2023) reported that southern districts of the State tend to be more diversified. Lower level of diversity index values in Ramanagara is confirmed by similar results reported by Pavithra *et al.* (2021).

Technological interventions are the pathways to increase farmer's income by way of improving productivity, reducing costs and expanding the nature of activities carried out. Diversification and intensification were the results of improved productivity leading to a combined effect on household income. The results demand for large scale extrapolation and scaling up of technologies that contributed to increased productivity. Although, there was increase in diversification in most of the study districts as explained by index of diversity, the extent of increase was low. Hence, there is a need for strategizing the diversification process which needs additional thrust through appropriate policies and programmes.

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