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Impact of crop integration on production and economics under temperate hill ecology of Jammu & Kashmir

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ABSTRACT

Crop diversification has proven its worth in all parts of the world including India. Prevailing agriculture scenario in the country demands more productive, profitable and sustainable cropping systems. Farm Science Centre (Krishi Vigyan Kendra) -Kulgam established an Integrated Farming System (IFS) model over an area of 1.0 ha in the year 2017 with agriculture, horticulture and dairy as its components and the study continued up to 2021. The aim was to test its significance in terms of production and income and subsequently present it to the famers during farm exposure and training programmes. Income obtained from the IFS was substantially higher than conventional cereal based cropping system. Net income from IFS showed a gradual increase from ₹233835/ha in 2017 to ₹790062/ha in 2020. The increase in the net income from the integrated farming system over conventional cropping system was 49.6, 144.9, 202.5, 406.0 and 335.0 % higher in 2017, 2018, 2019, 2020 and 2021, respectively. Benefit cost ratio of the crop component of the IFS fluctuated from 2017 to 2021. High Density Apple orchard recorded highest B:C ratio (3.86) among all the components. B:C ratio of dairy unit increased from 2.33 in 2017 to 2.79 in 2021.The striking feature of the IFS was the economic adversity coping up feature as observed from the higher returns from one component when the returns were not so good from other and vice versa.

1. Introduction

Mono-cropping over a large area and for long period is considered a major reason for decreased agro-ecological biodiversity associated with the prevalent agricultural production systems (Loh *et. al.,* 2022). This has also resulted into many other issues including soil health and nutrient imbalance (Jata *et. al.,* 2012), increased frequency and virulence of pest attacks (Krishnaiah and Verma, 2012) and uncertainty in farm income owing to chances of losses due to abrupt climatic conditions (Kumar and Meena, 2015) and market flexibility. In hills particularly, fragmented land remains a challenge. Proper resource management may however result in better crop productivity and cropping intensity here (Chand *et al.* 2011).Integration of crops may be a single solution to the many issues related to farming in the hills (Mubarak and Sheikh, 2014). Integration of animal component with other crops, particularly has proven more sustainable in terms of production and profitability (Yadav *et al* 2013). With this background, Krishi Vigyan Kendra Kulgam, SKUAST-Kashmir established an integrated farming System model over an area of 1ha to study its impact on farm production and monetary benefits under temperate ecology, as very less studies on Integrated farming System are reported from this part of the country.

2. Materials and Methods

Farm Science center (Krishi Vigyan Kendra) - Kulgam-SKUAST Kashmir is situated in District Kulgam in the Kashmir Division of J&K. It is located at Longitude of 75.331, Latitude of 33.644 and an altitude of 1853 m above mean sea level. In an effort to generate data under national agenda for increasing farmers income, an Integrated Farming System (IFS) unit was established by Kendra over an area of 1.0 ha with agriculture crops (0.75 ha), high density apple orchard (0.2 ha) and dairy unit (0.05 ha) as its components. Rice and maize mono cropping was adopted before the crop

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diversification in 2017. The site of study is characterized by temperate climatic conditions with mild summers and harsh winters. The site possesses facility of automatic weather station (AWS) for recording the weather parameters. The maximum temperature (25-35°C) was recorded May to August. The precipitation in the range of 75-100 mm per month was almost evenly distributed from May to September and then decreases drastically from October to November (25 to 30 mm per month). The soil of experimental site is silt loam in texture and has moderate fertility status with slightly acidic pH. The details of the crops and their varieties are given in Table 1. The area under different components and crop yield of different enterprises is shown Fig 1 and Tables 2&3. Monetary returns obtained from different farm enterprises were recorded and used for benefit cost analysis of the IFS as per the guidelines of Gittinger, 1972. The produce (grain) was sold at higher rates as seed to the Mega Seed Project SKUAST-K and economics also included contribution from the sale of straw and stover, which have good demand in the area for dairy and apple packing. System economic efficiency (SEE) over the years was calculated by dividing net returns obtained from whole IFS with number of days in a year (365).

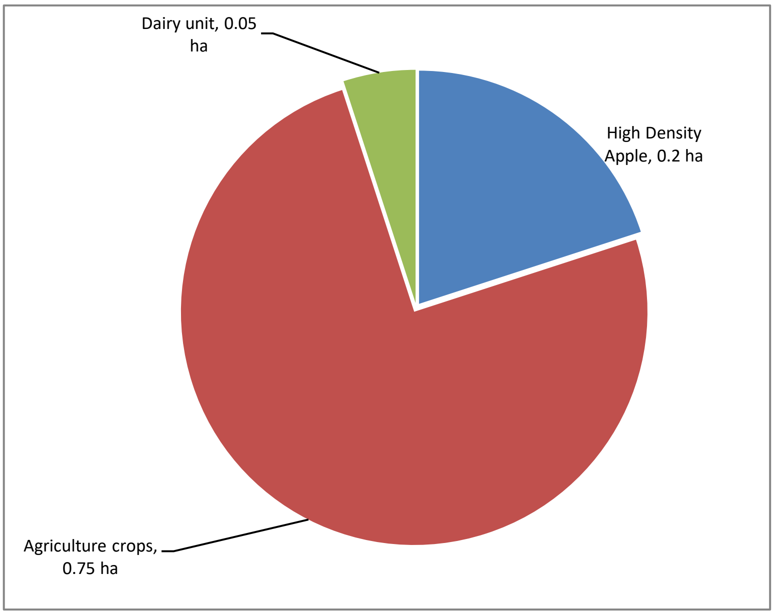

Figure 1. Area under different crops components

Table 1. Details of different corps and their varieties included in the experiment.

S.no	Name of crop	Variety	Source
1	Rice	Jhelum	MRCFC,SKUAST-Kashmir
2	Maize	Shalimar maize Composite -3	DARS,SKUAST-Kashmir
3	Soybean	Shalimar Soya -1	DARS,SKUAST-Kashmir
4	Moong	Shalimar Moong-1	DARS,SKUAST-Kashmir
5	Brown Sarsoon	Shalimar Sarsoon-2 (SS2)	MRCFC,SKUAST-Kashmir
6	Oats	Shalimar Fodder oat -1	DARS,SKUAST-Kashmir
7	Apple	Red Velox, Super Chief, Redlum Gala, Golden Reender, Golden Clone-B	Division of Fruit Science, ,SKUAST-Kashmir
8	Dairy	Cross Bred	MLRI,SKUAST-Kashmir

3. Results and Discussion

3.1 Crop Yields

The data on different crop components (Table 2 & 3) indicates that the crop yield varied over the years in different crops mainly due to the area allotted to each crop. The case was however different for High Density Apple orchard were yields increased consistently from 2018 to 2021. The increase in yield was 205% from 25q in 2017 to 76.3 q in 2021 from an area of 0.2 ha allotted to this component. This was attributed to the increase in fruiting area with increasing age of the plants and short gestation period compared to traditional apple plants (Badiu *et. al.*2015). High density apple orchards are therefore considered much productive than traditional orchards in terms of crop yield and quality parameters (Wani *et. al.,*2021). Milk and Farmyard manure (FYM) production varied from year to year from dairy unit initially started with two cows. Milk yield increased by 104% from 3428 litres in 2017 to 7026 in 2020. Milk yield however decreased again (3899 litres) in 2021owing to the less number of lactation days during the year and sale of a milch cow. The production of FYM increased by 120% from 2017 to 2020. The production was lower in 2021 compared to 2020 due to sale of animals and some low age animals in the unit. Badiyala *et al.*, 2012 reported that the integration of different components in horticulture-based cropping system improved the productivity and sustainability of crop enterprises.

Table 2. Year wise Area and yield of different crops before and after crop diversification.

Crop / Year	Rice		Maize		Soybean		Moong		Brown-sarsoon		Oats		Apple	
	Area (ha)	Yield (q)	Area (ha)	Yield (q)	Area (ha)	Yield (q)	Area (ha)	Yield (q)	Area (ha)	Yield (q)	Area (ha)	Yield (q)	Area (ha)	Yield (q)
2016*	0.8	32.3	0.2	8.3	-	-	-	-	-	-	-	-	-	-
2017	0.3	12.7	0.25	8.9	-	-	0.25	2.5	-	-	-		0.2	-
2018	0.2	12.1	0.2	8.6	0.1	3.3	-	-	-	-	0.3	10.4	0.2	25.7
2019	0.25	12.9	0.2	8.3	0.2	6.2	-	-	-	-	0.15	4.5	0.2	35.4
2020	-	-	0.23	11.0	0.2	6.4	0.2	2.3	-	-	0.17	5.5	0.2	51.2
2021	-	-	0.15	5.2	0.05	2.1	0.2	2.0	0.25	3.4	0.15	4.6	0.2	76.3

*Before Diversification.

Table 3. Year wise yield and economics of Animal component (dairy unit)

Year	No. of Animals	Milk yield (Litr.)	FYM (q)	Net income (₹.)			Total net income (₹.)	Total Cost of cultivation (₹.)
				Milk	Sale of Animals	FYM		
2017	2	3428.5	73.5	102855	25000	31750	159605	68298
2018	4	3903.5	119.0	117105	-	54500	171605	73480
2019	5	4567.0	154.5	137010	-	72250	209260	83480
2020	6	7026.0	162.0	245892	83600	78600	408092	160370
2021	5	3899.0	146.0	136484	101600	69000	307084	109790

3.2 Profitability

Cost of cultivation and income from different crops components of IFS varied with area allocated to each crop and number of animals in case of dairy unit (Table 4). Gross cost of cultivation showed increasing trend from 2017 to 2020 (Fig 2) in all components. Excluding dairy unit, a decrease in gross cost of cultivation was recorded in the year 2021. This may be attributed to the use of on farm inputs generated from IFS and less disease and pest incidence during the year due to favourable weather. The impact on income was much prominent in case of high density apple orchard and dairy unit (Table 4 and Fig. 3). The Income obtained from the IFS was substantially higher compared to the conventional cropping before diversification. Net income showed a gradual increase from ₹. 233835/ha in 2017 to ₹.790062/ha in 2020 (Table 4 and Fig.3). However, it was reduced to ₹. 679694 in 2021 mainly due to low milk and FYM production during the year. The increase in the net income from the integrated farming system over conventional cropping system was 49.6, 144.9, 202.5, 406.0 and 335.0 % higher in 2017, 2018, 2019, 2020 and 2021, respectively. Gopinath *et al.*, 2012 recommended integrated farming systems for production stability and economic viability of the farmers, especially small and marginal farms under changing climate scenario. The Benefit cost ratio of the Horticultural component (HDP) and dairy was high in 2020 and 2021 (Table 4). As the income started to flow from the newly established diary unit and apple orchard the benefit cost ratio of IFS increased consistently from 2019 onwards. High Density Apple orchard recorded highest B:C ratio among all the components in 2020 (3.86) and 20021(3.59). B:C ratio of dairy unit increased from 2.33 in 2017 to 2.79 in 2021. Net income analysis revealed that IFS attaining a more profitable equilibrium with every passing year with the highest recorded during 2020 (Table 4 & Fig. 025+3). These findings are in agreement with Yogesh *et al.*, 2016 and Palsaniya *et al*, 2021.

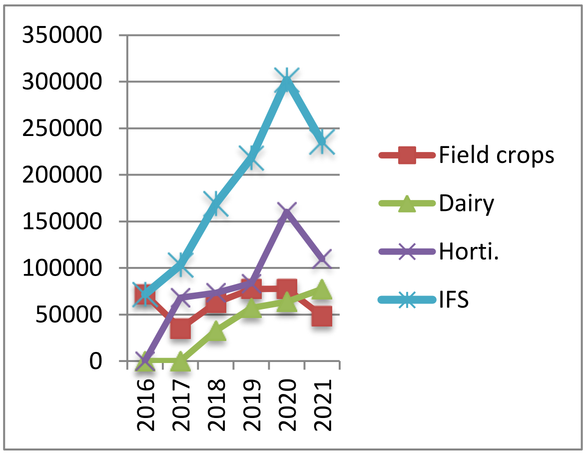

Figure 2. Cost of cultivation (₹)

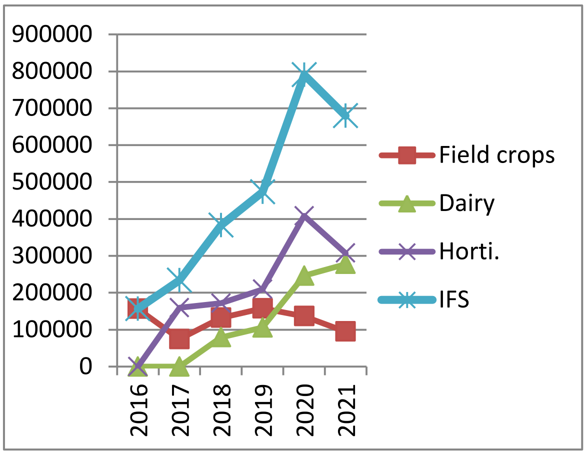

Figure 3. Net Returns (₹)

3.3 System economic efficiency

One of the basic advantages of Integrated Farming System is regular income per unit of time. How a cropping system impacts the income also determines its role in sustaining the livelihood of farming families. Calculating System Economic Efficiency (SEE) is therefore very important so that better options of crop production are demonstrated and promoted among farmers of the area (Rakesh *et. al.,* 2018). As illustrated in Fig 4 the system economic efficiency varied over the years and there was a consistent improvement in the SEE from ₹. 428/day in 2016 to ₹. 2166/day in 2020. So far as farmers income in the Jammu & Kashmir is concerned it is ranked among top five states and UT's in the country, with major contribution from Horticulture Sector (Anonymous 2022). Higher SEE in the integrated Faming System indicates that crop diversification to high value and compatible components like horticulture and dairy with other farm enterprises is more profitable and sustainable (Badiyala *et al.*, 2012).

Table 4: Costs and returns of the different crop components and system profitability as influenced by crop diversification.

Component / Year	Field crops			Fruit crop (HDP-Apple)			Dairy unit			Total of the system		
	Cost of cultivation (₹)	Net Returns (₹)	B:C	Cost of cultivation (₹)	Net Returns (₹)	B:C	Cost of cultivation (₹)	Net Returns (₹)	B:C	Cost of cultivation (₹)	Net Returns (₹)	B:C
2016	71900	156250	2.17	-	-	-				71900	156250	2.17
2017	35140	74230	2.11	-	-	-	68298	159605	2.33	103438	233835	2.26
2018	62710	132020	2.10	32930	79070	2.40	73480	171605	2.33	169120	382695	2.26
2019	77480	157630	2.03	57190	105810	1.85	83480	209260	2.50	218150	472700	2.16
2020	77700	136420	1.75	63850	246150	3.86	160370	408092	2.54	301920	790662	2.61
2021	48500	94930	1.95	77320	277680	3.59	109790	307084	2.79	235610	679694	2.88

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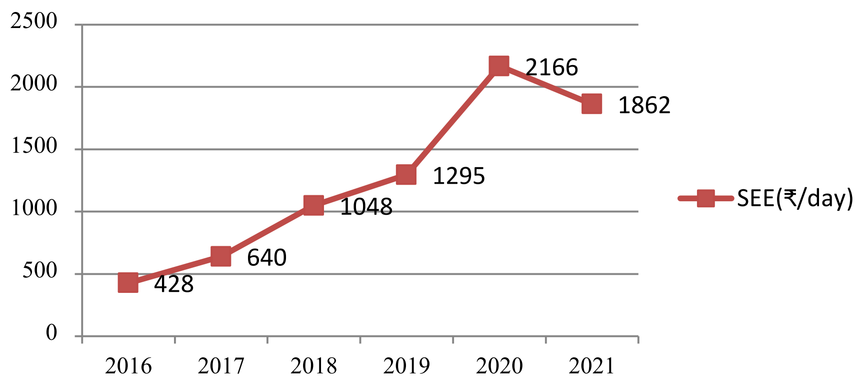
Fig 4: System Economic Efficiency(SEE) before and after Diversification



4. Conclusion

Under the changing climate and marketing scenario, the mono-cropping and double cropping systems are susceptible to the adverse impacts of abrupt climatic events, new insect pest and diseases incidence and market related risks. Diversification of the farm enterprises in IFS results in resilience and sustainability of the system. Efficient utilization of the farm by- products, their optimum recycling within the system, round the year availability of work and steady monthly flow of income makes the IFS a more stable and sustainable agricultural production system as compared to the conventional one. Standardization and popularization of location specific IFS models is therefore vital to sustain production and farm income and at the same time reduce various risks associated with farming.

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