INTEGRATED FARMING SYSTEM FOR SUSTAINABLE RURAL LIVELIHOOD OF SMALL AND MARGINAL FARMERS OF ARID AND SEMI-ARID REGIONS OF HYDERABAD KARNATAKA

Abstract

The research conducted on farming systems in India and other regions has provided valuable insights into the challenges faced by small and marginal farmers and their surrounding environment. By vertically integrating various agricultural enterprises such as crops, vegetables, livestock, horticulture, forestry, and fodder, and incorporating innovations in science and technology within a well-planned cropping pattern, optimal utilization of on-farm resources has significantly increased overall farm production and productivity. In the North Eastern Transitional Zone (Zone-1) and North Eastern Dry Zone (Zone-2) of the Hyderabad Karnataka Region, this integrated approach was put into practice through the "Integrated Farming System for Sustainable Livelihood – An UAS Dharwad Approach" project, which was funded by the Karnataka government, between 2010 and 2011.

Using the Participatory Rural Appraisal (PRA) technique, a total of 83 farm families were identified, and their farming situations were thoroughly analyzed and documented. This information served as the foundation for redesigning farming activities to create customized Integrated Farming System (IFS) modules. The tangible outcomes and quantified benefits of this initiative are as follows:

Significant increases in mean productivity were observed, with a 19% improvement in cereals, 27% in pulses, 15% in oilseeds, and 14% in commercial crops.

Maize demonstrated the highest Sustainable Yield Index (0.86) among field crops, while

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ridge gourd achieved the highest Sustainable Yield Index (0.85) among vegetable crops.

The introduction of IFS resulted in an incremental Benefit-Cost ratio (B:C) of 3.46, indicating enhanced economic security among the 83 farm families.

The integration of various enterprises led to a notably higher Sustainable Value Index compared to individual enterprises.

The adoption of labor-saving equipment, such as saral kurupi, improved sickles, cycle weeders, and rakes, resulted in significant reductions in drudgery (27.62%, 47.16%, 25.41%, and 40.11%, respectively), translating into labor cost savings ranging from Rs. 1095 to 1799 per hectare. Whole-farm net returns increased from Rs. 1,26,777 to 2,00,988 between the base year of 2009-10 and the assessment year of 2011-12, thanks to the implementation of IFS.

The enhanced economic security for farm households and the beneficial effects of the technologies were demonstrated by the improved B:C ratio of 3.46.Food consumption patterns showed increases in the consumption of milk, cereals, vegetables, and eggs, contributing to improved nutritional security. The project generated an additional 29 man-days of employment per farm, addressing employment security concerns. Overall, the project's successes greatly improved the food, economic, and livelihood security of farm families in Hyderabad, Karnataka's Zones 1 and 2, which include both arid and transitional areas.

Keywords: Farming system; Food; Income; Livelihood security; Sustainable Yield Index; Sustainable Value Index, Benefit: Cost ratio

I. INTRODUCTION

Only Rajasthan is more prone to drought in India than the state of Karnataka. Even yet, the state's long-standing cropping land use pattern has sustained both agriculture and the populace. The sustainability of the area is, however, seriously threatened by the recent invasion of western crops and high-yield variety seeds.Farmers have successfully adapted to the monsoon season by using integrated farming methods and mixed- and multicropping land use patterns. Based on factors such as temperature, precipitation, soil types, vegetation cover, terrain, topography, crop kinds grown in the area, and agricultural techniques, the state of Karnataka has been divided into ten agroclimatic zones.

The agro-climatic zone 1 and 2 are semi-arid conditions with moderate to low rainfall and soil types that are mostly loamy, sandy and sandy loam. The temperatures in these zones are high, and vegetation is mostly shrubs and xerophytic plants. Water scarcity is the major issue, and integrated farming systems can help to conserve water and improve crop yields. In these zones, agriculture is mostly rain-fed, and crops like cotton, jowar and groundnut are commonly grown. These systems can also improve the livelihoods of farmers by increasing their income and providing a more diverse range of products. In addition, they can reduce environmental pollution and improve the sustainability of agricultural practices. In addition, these systems can help to reduce input costs by using resources more efficiently.

1. The Integrated Farming System (IFS) is a complex network of interrelated components that includes labor, capital, plants, animals, tools, power, soil, and other inputs. It is governed by farming families to some extent and is subject to different levels of influence from institutional, political, economic, and other farm-level forces [2]. A sizable fraction of rural farm households in this region are small and marginal farmers within the current agrarian environment. These families frequently experience poor and persistent risks to their ability to support themselves, including issues with food security, income, unemployment, health, and education. As a result, especially in rainfed areas, many farmers have found it difficult to adjust to the shifting agricultural landscape. They are also extremely susceptible to natural calamities like floods and droughts, which often lead to mass migration to cities in quest of employment possibilities. In order to tackle these complex issues, the University of Agricultural Sciences, Dharwad (UASD) conducted demonstrations of innovative IFS solutions on farmers' fields in Karnataka state's Zones 1 and 2 in 2010 and 2011.

2. Guarantees the stabilization of the natural resource base at the farm level and provides enhanced chances for implementing one or more advanced technologies aimed at augmenting the farm's overall output and productivity.

3. Offers the chance to link various farm operations to create the ideal mix of businesses for the efficient use of natural resources available at the farm level and for the recycling of nutrients on the farm.

4. This method makes sure that a greater awareness is raised regarding the adoption of technology or technologies that can result in a sustainable production process and the creation of jobs on the farm to support the livelihood of rural farm families.

   All sites could spend less money on chemical fertilizers and plant protection chemicals if they implement Integrated Crop Management Practices (IFS). In addition to the wise use of necessary inputs, the detrimental effects of irresponsible chemical use could be mitigated to protect the environment. said that (6) that implementing IFS preserves and safeguards the environment's quality and resource base. Because departmental farming operations work together to achieve the farm's overall development, the farm is referred to by the IFS as an entity with a strong relationship. Thus, IFS provides an opportunity to adjust agricultural methods to suit particular farm situations.

II. MATERIAL AND METHODS

In 2010–2011, forty farming families took part in on-farm demonstrations in Zones 1 and 2 of northern Karnataka regarding the integration of various components with crops in IFS mode and the recycling of resources within the system. Table 1 lists the main attributes and cropping schemes. The zone's farmers and villages were chosen at random, and Participatory Rural Appraisal (PRA) provided logical data.Using this data, farming activities were redesigned to create customized IFS modules for various farming scenarios. Farmers with one to two hectares of arable land were chosen by the ToT centers under the designated agroclimatic zone. A relevant action plan was created and implemented on the farms in 2010–11 and 2011–12 based on the PRA analysis. In order to provide the farm family with a stable source of income through an economically sound model, various allied activities, including horticulture, dairy, and vermi compost pits, were appropriately integrated into the production system based on need, choice, and resources available on the property. Crop and animal wastes were recycled for vermi composting so they could be used on the crop field. Standard operating procedures were used to account for and budget for every aspect of farm operations.

III. RESULTS AND DISCUSSION

1. **Field Crops Production:** The North Eastern Transitional Zone (Zone-1) and North Eastern Dry Zone (Zone-2) of Karnataka encompass the Bidar and Gulbarga districts, characterized by moderate climatic conditions. Considering the specific agro-climatic features of Zones 1 and 2, a strategic approach was developed to enhance farm productivity. Farmers were advised to implement an action plan that placed significant emphasis on cultivating pulses, followed by cereals, oilseeds, and vegetables. To achieve this, improved crop varieties/hybrids were identified, and cost-effective crop production management practices were recommended to boost crop yields. This approach yielded positive results, with pulse productivity increasing from 5.33 to 7.10 quintals per hectare (Fig.1). Furthermore, the percentage increase in pulse productivity over the benchmark (BM) reached 29% and 33% for the years 2010 and 2011, respectively (Fig.2). In the case of sorghum and bajra, the introduction of improved cultivars, namely DSV-1 and ICTP-8203, helped meet both the family's food grain requirements and fodder needs. This intervention led to an increase in food grain productivity from the BM level of 4.5

quintals per hectare to a stable 5.67 quintals per hectare. Consequently, during the years 2010-11 and 2011-12, farmers achieved 29% and 51% increases in food grain productivity over the benchmark year, respectively. The productivity gains and Sustainable Yield Index (SYI) resulting from technological interventions for individual crops are detailed in table 2

Considering the appropriateness of crop selection, farmers were encouraged to engage in the cultivation of oilseeds, specifically Soybean (JS-335), both as a standalone crop and as an intercrop with pigeonpea. Alongside these field crops, farmers received guidance to venture into the cultivation of commercial crops such as cotton and sugarcane, as well as vegetables including brinjal, onion, and cucumber. These diverse crops played a vital role in diversifying farming activities, providing a steady income stream, and covering day-to-day farm expenses. The productivity data for various vegetable crops, along with their Sustainable Yield Index (SYI), can be found in table 3 and illustrated in Figures 3 and 4.

2. **Links of Allied Activities:** To support agricultural activities and create additional on-farm opportunities, farmers were provided education and guidance on animal husbandry practices, including dairy farming and backyard poultry keeping. Through this intervention, a total of 80 farmers significantly increased their annual milk yield from 18,000 liters to 631,450 liters. Likewise, the introduction of backyard poultry resulted in a production of 18,440 eggs per annum, contributing to increased farm income and improved family nutritional security. The diversification and intensification of farm enterprises also generated additional employment opportunities, with the number of man-days increasing from 7,287 to 7,974 in the year 2011. These findings align with the conclusions of [3], who similarly reported enhanced net returns, increased manpower, improved protein availability, and nutrient recycling through the introduction of dairy and poultry activities in the farming system.

3. **Recycling of Farm Waste:** Vermicompost production units were recommended as a means of recycling agricultural wastes; these farmers had regularly produced 2640 q. of vermicompost, which was then utilized in the crop production system. This made it abundantly evident that the cost of providing plant nutrients had decreased and that farm productivity had increased. This result is consistent with those found in references [7] and [9]. Between 96 (the benchmark year) and 105 man days (2011) of on-farm job possibilities were created mostly thanks to these initiatives. [5] provides support for this conclusion.

4. **Food consumption pattern (Per adult consumption Unit):** Food consumption pattern is important to ensure better nutrition and health status of the farm family. In the bench mark year it was noted that, consumption of cereals, vegetables, fruits, milk was considerably below the Recommended Dietary Allowance (RDA) suggested by the Indian Council of Medical Research. With the intervention of cultivating vegetables and inclusion of livestock the consumption of vegetables and milk products increased to an extent of 189% and 20% respectively (Fig.5). Similarly, the consumption of cereals increased to an extent of 26% with the intervention of cultivating improved and high yielding cereal crops. The consumption of other food groups namely, pulses, oils, sugar,

meat and egg did not differ during the adopted years however they were consumed as per RDA.

5. **Sustainable Yield Index:** Higher sustainable yield indices for crops that are cultivated on all farms show that crop productivity has stabilized after the intervention and has increased. Bajra recorded a higher (0.60) sustainable yield index (SYI) among the cereals in zone 1, 2. Bengalgram outperformed other pulses in terms of SYI. In comparison to the benchmark year, the assessment year (2011) saw a notable improvement in production across a variety of food crops, commercial crops, and vegetables grown. In zones 1 and 2, the yield increase resulting from various interventions in food grains, specifically in bajra, sorghum, and wheat, was 41, 84, and 80 percent. Productivity fluctuates, and in farming environments with constraints, interventions have a stronger impact and improve production by 38 to 80%, with yield stability being observed. This demonstrates that the whole farm IFS demonstration has a major impact due to the farmer's improved natural resource base and decreased risk.All farm families observed the concrete advantages of the newly implemented vegetable production strategy, which varied depending on the crops and farming conditions. Brinda, onion, and cucumber productivity increased 36, 26, and 20% in zones 1 and 2 in 2011–12 compared to the benchmark year 2009–10. Innovations in technology have led to higher sustainable yield indices in several vegetable crops. One of the key interventions that improved farm families' income, boosted cropping intensity, created jobs, and ensured nutritional security for farm families and the surrounding rural households was the introduction of new vegetable crops and varieties. [/2] It was also suggested that by including horticultural and vegetable crops into the current system, they would guarantee nutritional security and be able to provide two to three times as much energy on a given plot of land than grain crops.

6. **Analysis of Economic Indicators:** The fact that makes the IFS interventions highly relevant to our agrarian situations as they brought greater farm productivity gains and income security among the farm families. Data indicate that, the average net returns of 80 farmers were enhanced from Rs. 21078 to Rs. 43989 which is 121 per cent gain over benchmark year 2010-11 to 2011-12 with integration of enterprises on farm sites (Table-4). The individual components contribution to the total net returns was significant. [9] Also reported that inclusion of dairy component with agriculture was more beneficial and help to generate on farm employment.

7. **Cost Benefit Analysis and Marginal Rate of Returns:** Marginal rate of return is the incremental increase in net benefit divided by the corresponding increase in variable cost. Farmers undertake the change when they perceive that the benefits will out weigh the costs. The difference between the two is the net benefits. The additional cost that involved with the interventions were considered while computing the total cost of production by the individual farmers. The marginal rates of returns were significantly higher in all the farms with introduction of IFS technologies. The average total cost of farmers (80 Nos) was increased by 36 % and corresponding to this the average returns were also increased by 122 % indicating the greater benefits with technological innovations integrated in a farming system mode and farmers participatory approach. This was very well depicted by the average benefit: cost ratio which increased to 4.08 during the assessment year (2011-12) as compared to 2.50during the benchmark year

(2009-10) (Table-5). The incremental benefit cost ratio was positive and higher with introduction of IFS approach across the farm families (80 no's). The incremental benefit cost ratio was 7.44, indicating the impact of technologies and it showed greater economic security among farm families (Table-6). This high level of incremental benefit cost ratio made the farmers to accept the change in technology and interventions. The data clearly showed that, the IFS approach is more efficient to sustain the livelihood of farm families.

8. **Sustainable Value Index:** By combining suitable enterprises with cropping, income generation and year-round employment were achieved, alongside the efficient utilization of resources [5]. For a variety of farming situations, whole-farm analyses were carried out, with an emphasis on the small adjustments made by seasonal crops and other activities through the use of new technologies. Recording the expenses and revenues related to crop production and other agricultural activities allowed for the execution of economic analysis. The only products sold for cash and the inputs paid for with cash were taken into account when comparing the alternatives using monetary values. The sustainable value index in Zones 1 and 2 varied from 0.75 to 0.97; greater values were ascribed to the yield stability attained by IFS interventions (Fig. 4). [1] has observed similar results of an increased sustainable value index as a consequence of integrated farming methods.

IV. CONCLLUSION

Thanks to the adoption of Integrated Crop Management Practices, the implementation of IFS results in a decrease in expenditure on external inputs, such as chemical fertilizers and plant protection chemicals. Furthermore, the harmful effects of excessive chemical use can be reduced to safeguard the environment by using important inputs sparingly. As a result, IFS views the farm as a whole, strongly integrating interdepartmental farming endeavors with the goal of attaining overall farm development. In this regard, IFS provides a chance to customize farming technology to fit particular farm circumstances.

REFERENCES

[1] Barik, K. C., Mohanty, D., Nath, S. K., Sahoo, S. K. and Laba Soren, 2010. Assessment of integrated farming system for rainfed ecosystem in Deogarh district of Orissa. XIX National symposium on 'Resource Management Approaches towards Livelihood Security" 2 - 4 December, 2010. pp.172.

[2] Gill,M.S., Singh,J.P., and Gangwar,K.S. 2009. Integrated Farming System and Agriculture sustainability. *Indian Journal of Agronomy*54(2):128-139.

[3] Giridhar, K., Elangovan, A. V., Sharanagouda, A., Murugappa, T., Chandrappa,P., Khandekar, A. K., Samanta and Sampath,K.T.2010.Economic benefits of backyard poultry and Azolla cultivation in integrated farming system. In.XIX National symposium on 'Resource Management Approaches Towards Livelihood Security"2-4 December, 2010.pp.180.

[4] Jayanthi,C.2002.Sustainable Farming System and lowland farming of Tamilnadu. *IFS Adhoc Completion Report*.

[5] Jayanthi, C., Vennila, C., Nalini, K. and Myanavathi, V. S. 2010. Farmer participatory integrated farming sytem. XIX National symposium on 'Resource Management Approaches Towards Livelihood Security" 2 - 4 December, 2010. pp.175.

[6] Lal, R. and Miller, F. P. 1990. Sustainable farming system for tropics. Sustainable agriculture: Issues and Prospective. Vol. I (Ed.) R. P. Singh., Indian Society of Agronomy, IARI, New Delhi. pp.68-89.

[7] Mamle Desai,N.R.,Hilli,J.S.,Hanamanaikar,R.H. and Karuna Malshet.2010. An ideal farming sytem model for Northern transitional Zone of Karnataka. In.XIX National symposium on 'Resource Management Approaches towards Livelihood Security"2-4 December, 2010.pp.178.
[8] Radha,Y., Eshwara Prasad,Y. and Vijayabhinandana,B.2000. Study on income and employment generation on agricultural based livestock farming systems. Paper presented at VIII annual conference of AERA at TNUASU,Chennai,28029,December,2000.
[9] Shivani, Singh, R.D., Rajan, K.,Ray,P.K. and Singh,S.S.2010.Resource management in vegetable based integrated farming system for marginal farmers of Bihar. In.XIX National symposium on 'Resource Management Approaches Towards Livelihood Security"2-4 December,2010.pp.176.

Table 1: Characteristics of agro-climatic zones and description of the area under project

Sl. No	Zone	Name of agro-climatic zone	District under Zone	Characteristic features of the zone	Name of village, no. of farm families adopted District /Taluka /Village/Farmers (Nos.)
1.	I	North Eastern Transitional Zone	Bidar, Gulbarga (part)	Geographic Area : 8.61 lakh ha Cultivable area : 6.15 lakh ha Avg. rainfall : 870 mm/year Duration of rainfall : June to October Crop season :Kharif& Rabi Soil type :Lateritic & Black soils Important crops / cropping system : Maize+Tur(2:1),Greengram/Blackgram +Tur (2:1), Greengram/Blackgram, followed by Bengalgram/Rabijowar /Sunflower/Wheat, Sunflower followed by Bengalgram/Rabijowar	Dist: Bidar Tq. : Basavakalyan Villages : Mudabi & Bagduri Farmers : 40 Nos.
2.	II	North Eastern Dry Zone	Gulbarga (part) Raichur	Geographic Area : 17.35 lakh ha Cultivable area : 13.27 lakh ha Avg. rainfall : 710 mm/year Duration of rainfall: June to October Crop season : Kharif & Rabi Soil type : Meedium, black cotton soils/red soils Important crops / cropping system : Bajra+Tur (2:1), Sesame+Tur (2:1), Greengram/ blackgram+Tur, Groundnut+Caster (3:1), Ggram/Bgram followed by Rabijowar/Safflower/B.gram/wheat	Dist.: Gulbarga Tq : Afjalpur & Jevargi Villages : Madaritanda, Gour & Naribol Farmers : 40 Nos.

Table 2: Productivity (qha^{-1}) and Sustainable Yield Index in field crops as influenced by IFS interventions in Zone 1 & 2

Zone 1 & 2	Before intervention (BI)	After intervention (AI)		% Increase over BI		Standard Deviation	SYI
Food grains	**BI**	**2010**	**2011**	**2010**	**2011**	**SD**	**SYI**
Wheat	5.00	0.00	9.00	-	80.00	1.80	0.32
Bajra	4.60	6.25	6.50	35.87	41.30	1.86	0.60
Sorghum	3.90	7.03	7.19	80.26	84.36	1.82	0.59
Pulses	**BI**	**2010**	**2011**	**2010**	**2011**	**SD**	**SYI**
Redgram	4.90	7.72	8.00	57.55	63.27	1.98	0.61
Bengalgram	7.40	9.44	9.60	27.57	29.73	2.32	0.68
Blackgram	4.70	5.26	5.70	11.91	21.28	1.82	0.60
Greengram	4.30	5.00	5.10	16.28	18.60	1.74	0.60
Oilseeds	**BI**	**2010**	**2011**	**-**	**-**	**SD**	**SYI**
Soybean	0	10.06	11.2	-	-	1.537	0.496
Commercial crops	**BI**	**2010**	**2011**	**2010**	**2011**	**SD**	**SYI**
Cotton	17.5	24.5	36	40.00	105.71	3.81	0.62
Sugarcane	99.27	115	23	15.85	-76.83	7.71	0.62

Table 3: Productivity (qha^{-1}) and Sustainable Yield Index in vegetable crops as influenced by IFS interventions in Zone 1 and 2

Vegetables	Before intervention (BI)	After intervention (AI)		% Increase over BI		Standard Deviation	SYI
Zone-1 & 2	**BI**	**2010**	**2011**	**2010**	**2011**		
Brinjal	187.5	250	255	33.33	36.00	11.81	0.86
Onion	83.3	102.1	105	22.57	26.05	7.75	0.85
Cucumber	125	156.3	150	25.04	20.00	9.47	0.86

Table 4: Net returns Rs /ha as influenced by IFS demonstration in Zone- 1 & 2 (Total of 80 farmers)

Components	Agriculture			Horticulture			Animal Husbandry			Other enterprises (Vermicompost unit)		
	BI	2010	2011	BI	2010	2011	BI	2010	2011	BI	2010	2011
(Before adoption) Agri/Hort /AH/Other Enterprises	21078			625	1175	1210	0	8631	8976	Nil	5518	5328
(After adoption)												
Agriculture		24547	28475									
Agriculture + Horticulture				21703	25722	29685						
Agriculture + Horticulture + Animal husbandry							21703	34353	38661			
Agriculture + Horticulture + Animal husbandry + Other enterprises										21703	39871	43989

Table 5: Cost reductions (Rs.) started under IFS demonstrations (Per farmer)

Zones	No. of farmers	Avg. total returns (Rs)		Avg. total cost (Rs.)		Avg. Net returns		Avg. benefit cost ratio	
		BM	AI	BM	AI	BM	AI	BM	AI
Zone 1 & 2	80	22322	49510	8904	12113	13519	37398	2.5	4.08

Table 6: Average incremental benefit cost ratio (Per farmer in Rs.)

Zones	No. of farmers	Avg. add. Cost (Rs.)	Avg. Add. Returns (Rs.)	ICBR
Zone 1 & 2	80	3209	23880	7.44

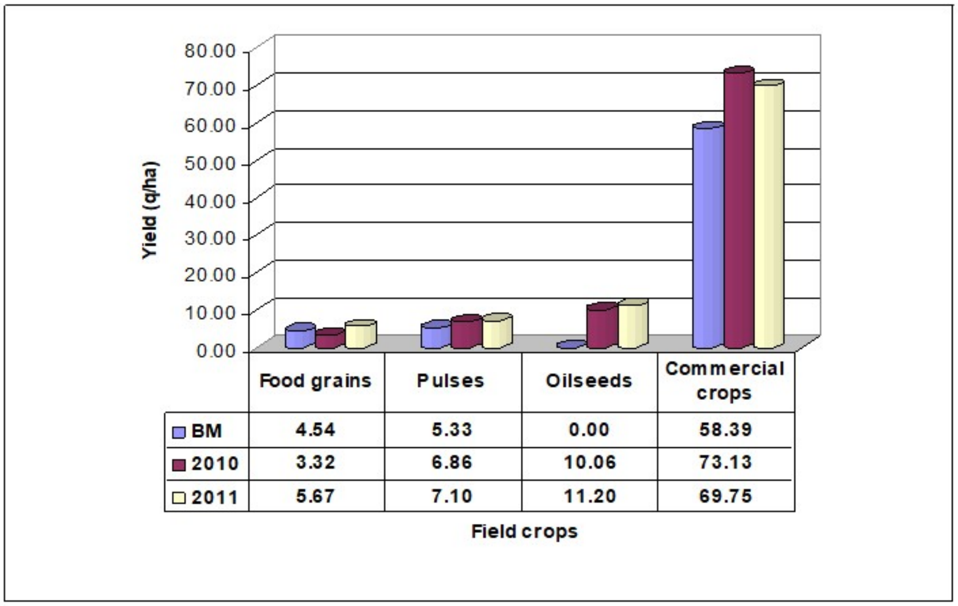

Figure 1: Productivity levels of field crops under IFS of Zone 1 & 2

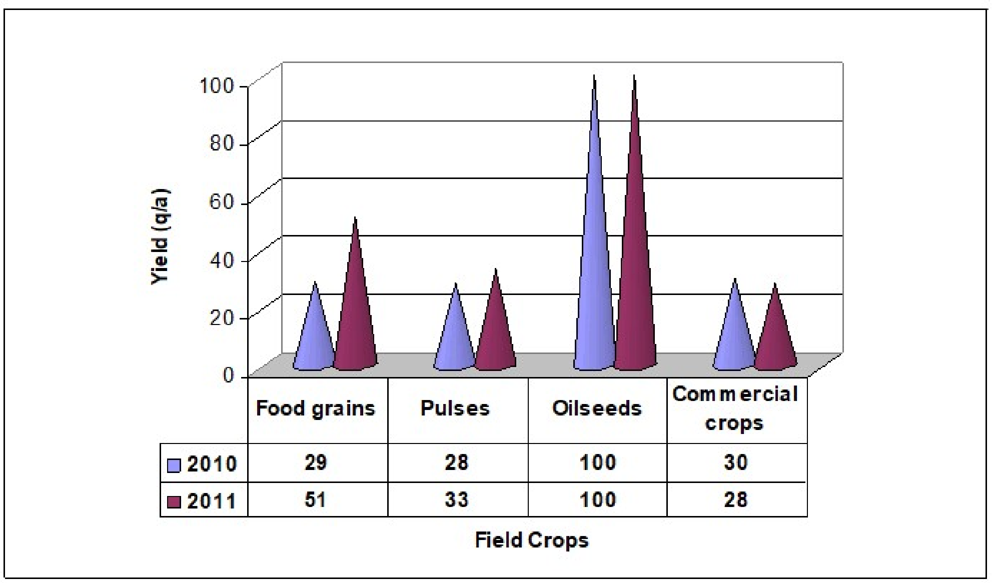

Figure 2: Percent increase in productivity level over Bench mark year (zone 1 & 2)

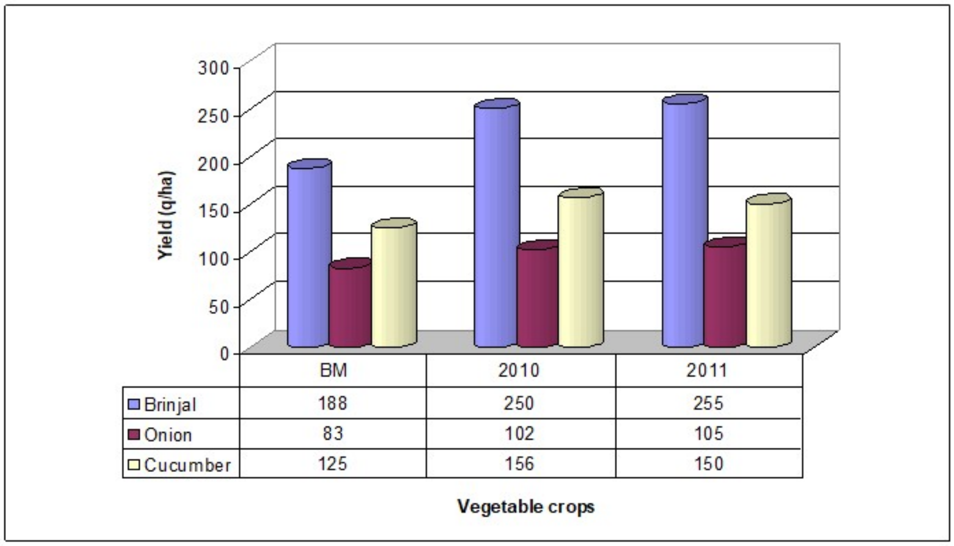

Figure 3: Productivity of vegetable crops under IFS (zone 1 & 2)

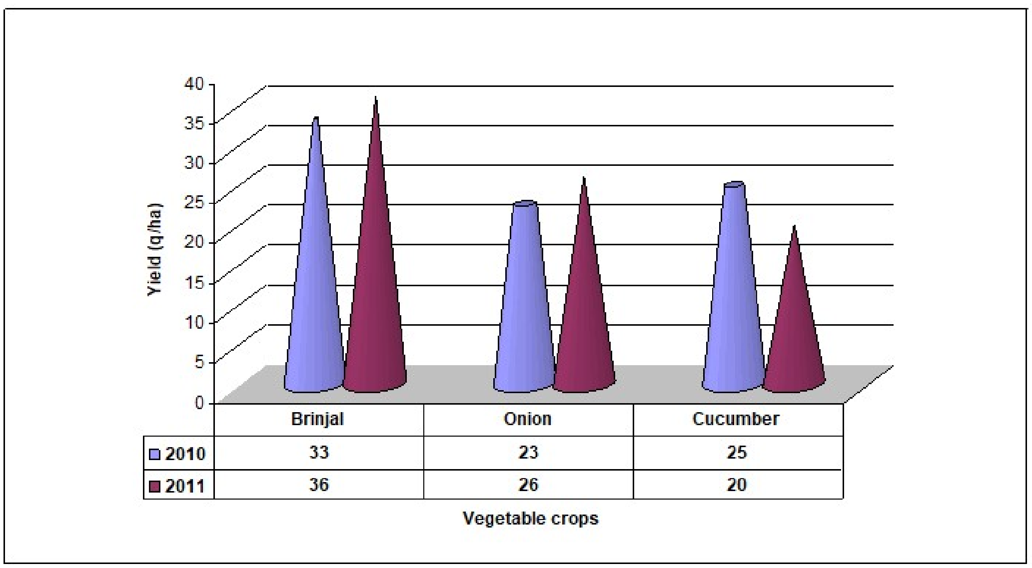

Figure 4: Per cent increase in average productivity level over Bench mark year (zone 1 & 2)

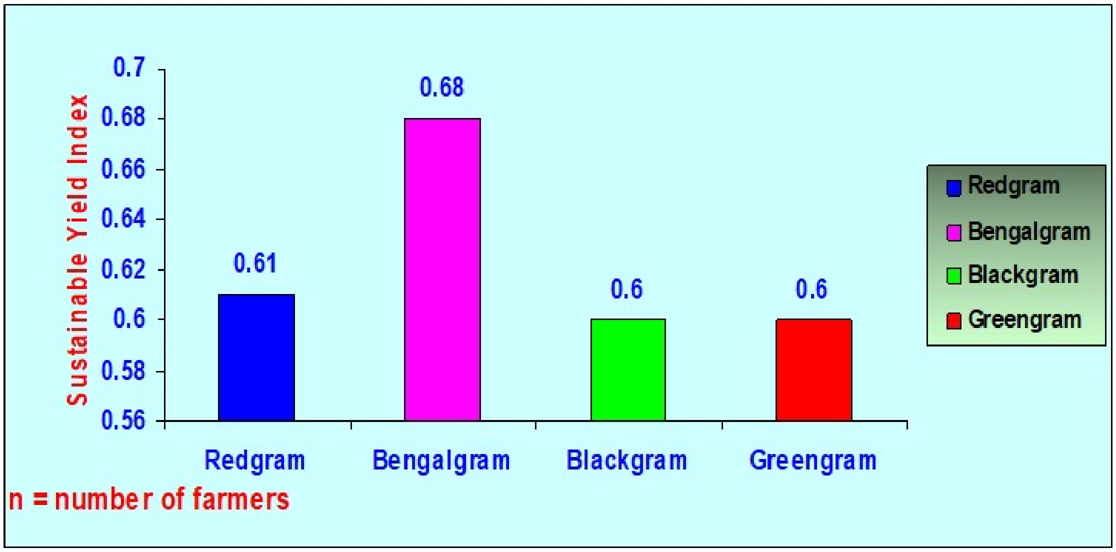

Figure. 5: Sustainable Yield Index of Pulse crops as influenced by IFS interventions in zone 1&2 (n=47)

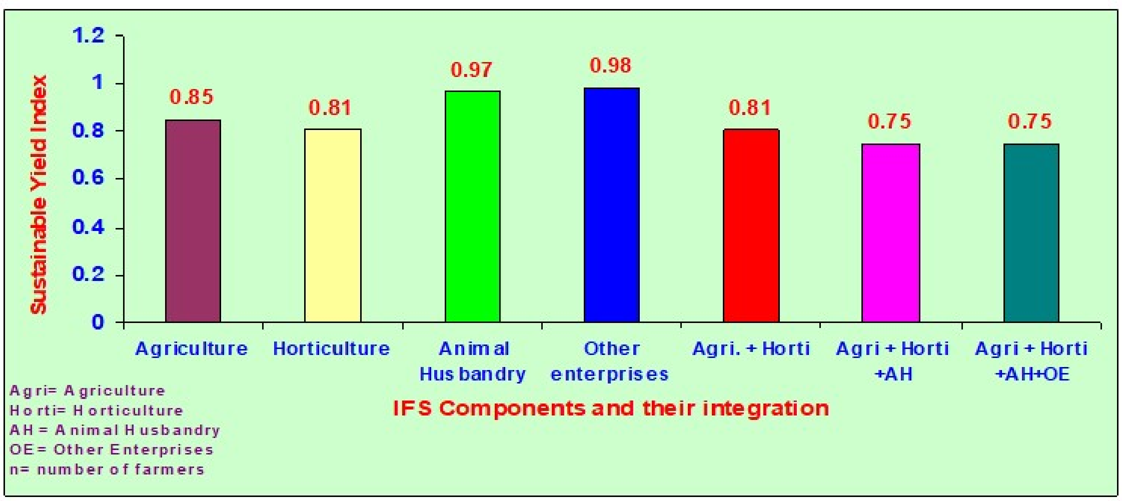

Figure 6: Sustainable Yield Index for Net returns as influenced by IFS interventions in zone zone 1&2 (n=80)