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Integrated Farming System for Sustainability and Livelihood Security - Success Story of a Farmer of Bengaluru Rural District

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ABSTRACT

A preliminary survey of farmers conducted at Chikkamaranahalli village of Nelamangala Taluk, Bangalore rural district under National Innovation in Climate Resilient Agriculture (NICRA) project revealed that the area was dominated by resource poor marginal and small farmers. The predominant resources, crops and cropping system of the area were assessed through participatory rural appraisal (PRA) techniques. Monocropping of finger millet with *akkadi* crops was dominated in the domain besides other problems like imbalanced fertilizer use, delayed onset of monsoon, intermittent dry spells, lack of awareness about improved varieties and dryland production practices. Therefore an investigation was carried out from 2014-15 to 2017-18, to find out a sustainable cropping system model, which is economically viable by integrating the different components like crops, livestock and fishery in an area of 2.5 acre land holding. Four cropping system models viz., F_1: finger millet based cropping system, F_2: Groundnut based cropping system, F_3: Pulse based cropping system and F_4: Mango based Agri-Horti system were developed to find out the best package on the landholding suitable for the region. Intercropping of finger millet - pigeonpea in 8:2 proportions fetched higher net returns of Rs. 7622 ha^{-1} compared to farmers practice of growing akkadi finger millet (Rs. 4129 ha^{-1}). Similar was the trend in groundnut based cropping system, where in intercropping of pigeonpea with groundnut (8:2) resulted in higher groundnut pod equivalent yield of 434 kg ha^{-1} and B:C ratio of 3.43. With respect to pulse based intercropping system, intercropping of pigeonpea with field bean fetched higher returns (Rs.7936 ha^{-1}) compared to that of with cowpea (Rs. 6767 ha^{-1}). In mango based agri-horti system growing of finger millet/ horsegram along with mango not only helped in generating additional remunerative income of (Rs. 2804 ha^{-1}) but also enhanced the soil fertility status compared to growing sole mango crop. Livestock was an integral part of farming system along with other agricultural components like horticulture, vegetables, agro forestry etc. Integration of fisheries along with livestock components fetched net returns of Rs.6000 and 39650/year respectively and required higher man days 235 over conventional cropping system. Thus integrated farming system with livestock + fisheries along with profitable intercropping system was most beneficial system which could augment in increasing the income of farmers to improve their socio-economic status.

Keywords: Monocropping, Akkadi, Agro-Forestry, Livestock, Agri-Horti

KARNATAKA is a miniature India considering its diversified agro-climatic conditions and cropping patterns. The state has 66 per cent of rural population and 56 per cent of the workers have been classified under the cultivators and agricultural labourers. The state has ten diversified agro-climatic zones including plains, plateau and hills types of natural vegetation, crops and resources available varies to a great extent, similarly size and population of livestock, inhabited in the different agro-climatic zone also varies largely (Anonymous, 2015)

In India, where majority (84.97%) of the farming community belongs to small and marginal farmers having only 44.31 per cent of the total operational area, specialized farming may not be viable and sustainable in the long run (Singh *et al.,* 2010). The average size of the farm in India has been declining and over 80 million out of 105 million farmer's operation holding are below size of 1.0 ha and poses a serious problem.

The farmers particularly those belonging to small and marginal category are unable to meet both ends with

income from cropping alone. The situation is further weakened due to repeated failure of monsoons increasing population and decline in per capita availability of land on other side. Further, there is hardly any scope for horizontal expansion of land and only vertical expansion is possible by integrating various farm enterprise requiring less space and time. Thus, ensuring periodic income to the farmer (Byrene *et al.,* 2010). The integrated farming systems, therefore assumes greater importance for sound management of farm resources to enhance the farm productivity, reduce environmental degradation, improve the quality of life of resource poor farmers and to maintain the sustainability. Further rainfed areas with climate change are characterized with crop failure, lower sustainability and poor livelihood. Integrated farming system approach is the only avenue for enhancing farmer's income, bringing sustainability and livelihood security of small and marginal farmer's especially under rainfed ecosystem. Thus, an operational on-farm demonstration of integrated farming system approach was planned to document system productivity, economics and livelihood.

Materials and Methods

The study area

Study was initiated during 2014-15 to 2017-18 at farmer's field of NICRA operational area at Chikkamaranahalli cluster, Nelamangala Taluk, Bengaluru Rural District which comes under eastern dry zone (zone-5) of Karnataka. The normal rainfall of the area is 751.9 mm characterized with erratic distribution.

Data Collection

The detailed inventory of the farmer was made to characterize resources and formulate the appropriate proposition of different components using questionnaire and personal interview. The soil status was characterized for its physical and chemical properties before taking up interventions using standard procedures.

Intervention

Farming was the prime occupation of the farmer with dairy farming as subsidiary enterprises. Farmer had a farm pond of 250m^3 capacity without lining and was growing finger millet + *akkadi* in traditional system. The farmer was advised to intensify cropping system with finger millet + pigeonpea (8:2), finger millet varieties for different sowing windows, pigeon pea + field bean/cowpea, (1:1), groundnut + pigeonpea (8:2) and also alternate land use system of mango + finger millet / horsegram based Agri-Horti system. Also agro-forestry species (silver oak) was introduced on bunds besides dairy enterprise. The detailed data on various inputs for different enterprises and output on daily basis were documented. The farm pond was lined with brick and advised to divert runoff water into pond, cultivate *azolla* and fishes besides giving protective irrigation. The data obtained were analyzed for yield economics, rain water use efficiency and employment generation by adopting standard procedures.

Results and Discussion

Among the three varieties of finger millet, long duration variety MR-1 recorded a net income of Rs.8609, followed by the medium duration variety GPU-28 (Rs.8130) and short duration variety GPU-48 (Rs.7487) under late sown condition. The farmer was convinced with the performance of MR-1, GPU-28 and GPU-48 for early, mid and late sowing conditions (Table-1) respectively. Intercropping of finger millet + pigeonpea (8:2) resulted in higher yield (636 kg) and net returns (2.51) compared to finger millet + *akkadi* crops.

Groundnut + pigeonpea (8:2) intercropping, and opening of conservation furrow in between paired rows of pigeonpea at 30 days after sowing with improved high yielding varieties and production practices increased the yield of main and intercrop (23%) as compared to traditional production practices. The farmer was very much impressed with the performance of both main and intercrop and paved way for horizontal spread of improved technology.

TABLE 1

Comparative economics of IFS under rainfed condition (pooled data of four years)

Finger millet based cropping system						
Intervention		Area (ha)	Yield* (kg)	CoC (Rs)	NR (Rs)	B:C
Improved practice	FM + PP(8:2)	0.2	636	5491	7622	2.51
Farmers practice	FM + Akkadi	0.2	492	5820	4129	1.71
*Finger millet grain equivalent yield						
Employment generation (man days)		55				
Finger millet Varieties						
Improved varieties	MR-1	0.2	434	4802	8609	2.82
	GPU-28	0.2	417	4802	8103	2.71
	GPU-48	0.2	409	4802	7487	2.61
Farmers practice	Local	0.2	362	4802	5236	1.88
Employment generation (man days)		50				
Groundnut based inter-cropping system						
Improved practice	GN + PP(8:2)	0.1	434	7135	17341	3.43
Farmers practice	GN + Akkadi	0.1	333	6641	12045	2.81
* Groundnut pod equivalent yield						
Employment generation (man days)		40				
Pulse based inter-cropping system						
Improved practice	PP+FB (1:1)	0.1	119	2874	7936	3.76
	PP+CP (1:1)	0.1	105	2874	6767	3.35
Farmers practice	Sole PP	0.1	84	2365	5192	3.20
* Pigeonpea equivalent yield						
Employment generation (man days)		20				
Mango based Agri-Horti system						
	Mango + FM/HG	0.2	406	3776	8424	2.23
	Sole Mango	0.2	349	3120	5620	2.80
* Mango equivalent yield						
Employment generation		50				
	Fodder crops /leaf forage	0.1	18000	2500	8000	4.0
	Employment generation	20				
	Leafy vegetables	-	-	1800	1700	1.94
	Employment generation (man days)	20				
	Cows	(2 no's)	2600lt	25350	39650	2.56
	Employment generation (man days)	235				
	Fisheries	0.04	60 kg	-	6000	6000

CoC: Cost of cultivation NR: Net returns

FM: Finger millet, GN: Groundnut, PP: Pigeonpea, HG: Horsegram, FB: Field bean, CP: Cowpea

Similarly, sowing of pigeonpea + cowpea (1:1) or pigeonpea + field bean (1:1) cropping system with improved high yielding varieties fetched higher income of Rs. 6767 and Rs. 7936 respectively, as compared to growing sole crop of pigeonpea (Rs. 5192/-).

The farmer was maintaining three milch cows and growing fodder maize in 0.1 ha area to meet the fodder requirement. *Azolla* grown in farm pond was fed to cows along with concentrated feeds and recorded on an average increase of 1.5 liters milk per day realizing an additional net income of Rs. 39,650 from dairy component.

Fish rearing in farm pond helped to realize additional net return of Rs. 6000. Further, the kitchen garden maintained around the farm pond (drumstick, chilli, curry leaves and nourishing mango seedling) yielded a profit of Rs. 1700/-. Similar results were reported by Dey *et al.* (2007); Nhan *et al.* (2007); Knondker and Diemuth (2011)

Before the introduction of improved interventions, the farmer was growing finger millet + *akkadi* crops and sole crops like pigeonpea and groundnut, which was enough to feed his family without any additional income for livelihood. Sometimes due to erratic rainfall, there would be complete crop failure leading to distressed condition of the farmer. In this situation real-time contingent crop planning worked well with the advice given on various technologies like rainwater harvesting, growing of vegetables using farm pond water, finger millet + pigeonpea (8:2), groundnut + pigeonpea (8:2), pigeonpea + cowpea / field bean (1:1) intercropping system etc. and subsidiary activities like dairy fishery, *azolla* cultivation and others that helped him to realize additional income and employment

The integration of more components at the same time, in same place, favoured for obtaining more income in a unit space and time, which in turn helped for obtaining more diversity compared to practicing a single enterprise. Similar findings was obtained by Devendra & Thomas (2002); Joshi *et al.* (2006) and Byrene *et al.* (2010).

The farmer undertook different cultivation practice and introduced improved technology, which made him to realize profit besides conserving the natural resources *viz.*, soil, water and other biomass. The year wise net income realized with different interventions under rainfed conditions by the farmer even under erratic rainfall condition showed that the farmer could generate employment for 438-460 man days with IFS approach (Table 2) with improved net income ranging from Rs. 1,11,249 to 1,43,735 even during the deficit

TABLE 2

Year wise net income generated by different interventions under rain-fed conditions

Year	Net income (Rs)	B : C	Employment generation (man days)
2014	1,43,735	2.29	460
2015	1,38,362	2.71	440
2016	1,11,249	2.31	438
2017	1,19,235	2.76	456

rainfall years. Similar results with IFS were earlier reported by Moll (2005); Ramrao *et al.* (2006); Shabanali Fami (2006) and Ram *et al.* (2008).

Further there was improvement in soil health in-terms of organic carbon (0.24 - 0.31%) and available major nutrients buildup N (130.20 kg) P_2O_5 (28.20 kg) and K_2O (192.5 kg) by following integrated farming approach (Table 3).

TABLE 3

Soil properties initial and after implementation of IFS

Parameters	Initial status	Present status
pH (1:2:5)	5.90	5.93
EC (dS m^{-1})	0.12	0.13
OC (%)	0.24	0.31
Av.N (kg ha^{-1})	100.80	130.20
Av.P_2O_5 (kg ha^{-1})	22.80	28.20
Av.K_2O (kg ha^{-1})	167.9	192.5

The main factors contributing for the success of farmer was *ex-situ* harvesting of run-off water, storing in lined farm pond and efficient utilization of the stored water by adopting IFS approach. After the success of these intervention, many farmer in and around the village expressed their interest and implemented different component and technologies,

The Integrated farming system with improved varieties and cultivation practices along with other subsidiaries like fish and dairy was found to be most beneficial system for augmenting the income of small and marginal farmers to improve their socio-economic and livelihood status.

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