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Impact of technological innervations for efficient farming systems in village clusters of Redwa district Akola of Maharashtra

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Abstract
Research and developmental initiatives under RIFS implemented in the representative village of Redwa of Akola district in M.S. are reported in this study. Details of 28 households pertaining to demographic characteristics, land use, means of livelihood, etc. were studied. Analysis of 20 farmers from rain-fed situations and 08 farmers from partially irrigated situations from Redwa village-Ta-Barhsitakli, Dist-Akola under different categories of farmers (*viz.* Marginal and small) with adoption of different cropping systems (*viz.* CLR and CLRSR) showed that the higher net monetary returns were gained wherein the interventions for crop, large ruminants and small ruminants were adopted by the farmers as compared to their traditional farming system (Without intervention). Crop interventions (*viz.* opening of furrows, foliar spray of 19:19:19 mix fertilizer, and protective irrigation in partially irrigated situations) resulted in higher equivalent yield of crops. Implementation of livestock interventions (*viz.;* vaccination and feeding of green foliage of lucerne/ berseem/minerals and concentrates) resulted in higher milk yield in large ruminants (i.e. cow and buffalo) with good health, higher man days in case of bullock pair and higher meat returns and better weight gain with good health in small ruminants (*i.e*; goat) as compared to control.

Keywords: Rainfed, innervations, sustainability, technological innervations

Introduction
The growth rate of agriculture in the recent past is very slow in spite of the rapid economic growth in India. The current scenario in the country indicates that area under cultivation may further dwindle and more than 20% of the current cultivable area will be converted for non-agricultural purposes by 2030. The operational farm holding in India is declining and over 85 million out of 105 million are below the size of 1 ha. Due to ever increasing population and decline in per capita availability of land in the country, practically there is no scope for horizontal expansion of land for agriculture.

The Integrated Farming Systems (IFS) therefore assumes greater importance for sound management of farm resources to enhance the farm productivity and reduce the environmental degradation, improve the quality of life of resource-poor farmers, and maintain sustainability. In order to sustain a positive growth rate in agriculture, a holistic approach is the need of the hour. An integrated Farming system is a mix of farm enterprises in which farm families allocate resources for efficient utilization of the existing enterprises for enhancing productivity and profitability of the farm. These farm enterprises are crop, livestock, aquaculture, agro-forestry, agri-horticulture, and sericulture. IFS a judicious mix of one or more enterprises along with cropping there exists a complementary effect through the effective recycling of wastes and crop residues which encompasses an additional source of income to the farmer. The area under the study is facing problems like low productivity due to delayed arrival of monsoon, prolonged dryspell, unexpected heavy rains, and lack of irrigation sources, animal health facilities and rural employment. Under this situation it is important to ensure the sustainability in production on farm through integration of diverse enterprises of different economic importance along with the recycling of wastes. Therefore, identification of appropriate farming systems for obtaining fairly high productivity with considerable scope for resource recycling and encouraging rural employment is vital. With this background, this study is an attempt to identify the existing traditional farming systems and develop an efficient farming system for increasing and stabilizing the farm income and employment in the dry areas of Akola district through rain fed integrated farming systems (RIFS) approach.

The key success to these farming systems is effective crop-livestock integration involving the recycling of nutrients within the system. A particular challenge facing farmers is to minimize nutrient losses through good management (Powell and Valentin 1997) [6]. improved feed production, quality, availability, and more efficient feeding systems; new ways to capture and conserve nutrients excreted by livestock; improved manure spreading techniques; and cropping systems that reduce nutrient losses and can improve livestock impacts on the soil environment.

Materials and Methods

Demographic characteristics of sample village

The study area is located in Rewda village of district Akola in the Maharashtra, India. It is enlisted 240 farmers of Redwa village. A baseline study was conducted on 28 farmers to study on current agricultural practices, crop yield, types of equipment, etc.

Soil and Land use

Table 1: Land use pattern in the project cluster (year 2021)

Particulars	Area (ha) of Redwa
Total geographical area	660.34
Pasture land area	112.82
Permanent fallow	49.64
Current fallow	48.24
Uncultivable wasteland	49.64
Net sown area sown	467.77
Cropping intensity	120.9

Results and Discussion

Initially there was only *kharif* crops were taken for cultivation. There is change in scenario by interventions in cultivation of crop by efficient utilization of natural resources. There is two types of farming situation *viz.* partially reregulated (42) and rain fed (16) sp mainly technologies are implemented for rain fed situation, Farmers are categories into marginal (10), small (10) medium (08), in this small farmers category is very prominent whereas large farmers category is very less.

Table 2: Profile of Sample

Farmers Category	Farming Situation		
	Rainfed	Partially Irrigated	Grand Total
Marginal	06	04	10
Small	06	04	10
Medium	04	04	08
Grand Total	16	12	28

In rainfed situation manly farming system for *kharif* season which include soybean + PP (6:1) on cotton + PP (7:1) and in sole crop situation sole cotton / soybean / GG/ Black gram were taken for economic benefit. In this situation there are small (6), marginal (6) and medium (4) farmer's categories.

Following interventions were suggested like the opening of furrow @ 30-35 DAS spraying of 2% 19:19:19 at PDS in soybean and also for cotton during boll initiation stage. Similarly, livestock rearing are there farming system *viz.* only crop, crop with large remnants, crops with large and small ruminants. In this vaccination and feeding of berseem and lucerne to large and small ruminants were taken.

Table 3: Details of villages selected and interventions for strengthening of RIFS in rainfed situation

Farming system	Farmers' category And Cropping system		Interventions
Soybean + Pigeonpea (6:1) Sole Soybean Green gram Blackgram Cotton + Pigeonpea (7:1)	Marginal		▪ Opening of furrows in each row at 30-35 das ▪ Spray of 2% 19:19:19 at pod initiation stage in soybean and boll initiation stage in cotton ▪ Control ▪ Vaccination ▪ Feeding of berseem and lucerne to large and small ruminant
	2	C	
	2	CLR	
	2	CLRSR	
Soybean + Pigeonpea (6:1) Cotton + Green gram (1:1)	Small		
	2	C	
	2	CLR	
	2	CLRSR	
Soybean + Pigeonpea (6:1) Cotton + Green gram (1:1) Sole Blackgram	Medium		
	2	C	
	2	CLR	
	16		

Impart of Interventions

In rain fed farming (0-1 ha) marginal group the effect. The effect of different interventions like opening of furrow increase 11.18% over control. The spray of 2% 19:19:19 at pod initiation stage in soybean increases 14.21% over control in (soybean +PP (6:1). Whereas small farmers group (1-2 ha) at cotton + PP (7:1) cropping there is an increase of 6.80% over control by opening of furrow and 11.21% increase over control by spray of 2% 19:19:19 at pod initiation stage.

There are 16 rainfed farmers which are having large ruminant as well as small ruminants. There are 12 partially irrigated farmers which are having large ruminants.

Table 4: Impact of different interventions on the yield and economics of farmers in rainfed situation

Interventions	Rainfed Farming (1-2 ha) Small							Soybean+ Pigeonpea (6:1)		
	Soybean grain yield Kg/ha	Soybean straw yield Kg/ha	Pigeonpea grain yield	Pigeonpea Straw yield	Soybean equivalent yield	GMR (Rs ha^{-1})	COC (Rs ha^{-1})	NMR (Rs ha^{-1})	B:C	% Increase over control
Control	1443	1803	750	1125	2465	85687	30983	54704	2.77	0.00
Opening of furrow	1494	1867	785	1178	2564	89127	31112	58015	2.86	4.01
Spray of 2% 19:19:19 at pod initiation stage in soybean	1528	1909	802	1203	2621	91114	31188	59925	2.92	6.33

By adopting the intercropping system soybean + PP (6:1) with large ruminant have 65 to 91 employment generation (man days) as compare to only intercropping system (76 man days). In case of application of interventions spraying of 2% of 19:19:19 at PIS pod initiation stage in soybean has net returns of Rs, 59469/- ha^{-1}. In the lowest employment generation 63 man days only was found in sole soybean. In case of buffalo rearing case, buffalo rearing has this highest 183 employment generation man days.

Partially irrigated (30%) situation

In this situation also there is two types of farming system were undertaken soy + PP (6:1), cotton + green gram (1:1), for sole farming only soybean / sole black gram is taken sole cotton. During Rabi season chickpea is grown. In this situation also farmer's category *viz.* Marginal (4) small (4) and medium (4) which include only crop growing crop growing with large ruminants/small ruminants. In this situation there are prominent innervations like opening of ferrous at 30-35 DAS, spraying of 2% 19:19:19 at pod initiation stage in soya, and boll development stage in cotton.

Table 4: Details of villages selected and interventions for strengthening of RIFS in irrigated (30%) situation

Farming system	Farmers' category		Interventions
Soybean + Pigeonpea (6:1) Sole Soybean Sole Blackgram Cotton + Green gram (1:1)	Marginal		▪ Opening of furrows in each row at 30-35 DAS ▪ Spray of 2% 19:19:19 at pod initiation stage in Soybean and boll development stage in cotton ▪ Protective irrigation at pod development stage in soybean and at boll development stage in cotton. ▪ Control ▪ Vaccination ▪ Feeding of bersem and lucerne to large and small ruminant
	C	2	
	CLR	2	
Soybean + Pigeonpea (6:1) Sole Cotton	Small		
	C	2	
	CLR	2	
Soybean + Pigeonpea (6:1) Sole Soybean Cotton + Green gram (1:1) Sole Blackgram Sole Green gram	Medium		
	C	2	
	CLRSR	2	
	12		
Rabi chickpea under partial irrigated condition	Marginal		▪ One protective irrigation at flowering stage. ▪ Two protective irrigations at flowering and pod development stage. ▪ Foliar spray 19:19:19 at pod development stage. ▪ (Pre sowing irrigation)
	Small		
	Medium		

Impart of Interventions

In Partially irrigated situations

There are 12 partially irrigated situations in which intercropping systems with the large ruminant rearing and small ruminant rearing farmer's groups are included.

Table 5: Impact of different interventions on the yield and economics of farmers in a partially irrigated situation

Components of the farming system	Area (ha)	Details of interventions given during 2020-21	Main crop equivalent yield (kg ha^{-1})	Cost of cultivation (Rs ha^{-1})	Net Returns (Rs ha^{-1})	Employment generation (man-days)
Crop/Intercropping system						
Crop 1:Soybean+PP (6:1)	1.20	Opening of the furrow in each row at 30-35 DAS.	1938	30484	56016	76
Soybean+ PP (6:1)		Spray of 2% 19:19:19 at pod initiation stage in soybean.	2008	30585	59035	76
Crop 2: Cotton+ PP (8:1)		Furrow opening	1647	45351	50142	121
Cotton+ PP (8:1)		Spraying of 2% Urea at flowering and KCL at boll development.	1706	45593	53337	121
Livestock (L) and number of animals						
L:1: Cow-01		Vaccination Feeding of lucerne grass with concentrates and mineral mixture.	561 (milk Lit/year)	4675	11033	91
L:2: Buffalo-01			1100 (milk Lit/year)	15800	26000	183
L:3: Goat-04			Sale of 7 kids for meat purpose	3500	21000	137

There is mainly a cotton + PP (8:1) intercropping system which generated the employment of 121 days with a net return of Rs. 50142/- to Rs. 5337 by furrow opening and spraying of 2% urea at flowing and KCL at boll development stage respectively.

More particularly, the farm surveys showed that cattle kept mainly for milk, contributed 32 percent and 20 percent for tribal and non-tribal ethnic groups respectively (Patil and Udo 1997) [4]. In an integrated system, livestock and crops are produced within a coordinated framework. (Van Keulen and Schiere, 2004) [5]. The waste products of one component serve as a resource for the other. For example, manure is used to enhance crop production; crop residues and by-products feed the animals, supplementing often inadequate feed supplies, thus contributing to improved animal nutrition and productivity. In cotton + soybean (1:1) with productive irrigation has maximum net returns Rs. 73710/-ha^{-1} with the employment generation of 93 man days.

Rearing of one bullock pair gives 55 employment generation (Man days) with net returns of Rs. 17050/-. So the combination of cotton + soybean (1:1) with protective irrigation with one bullock pair rearing gives net returns of Rs. 90760/- (Rs.73710 + Rs.17050) generation of 148 man days over control. Livestock and crop production systems are an integral part of one another (Kallah and Adamu 1988) [1]. Crop residues provide fodder for livestock (Van Raay and de Leeuw 1971; Al hassan *et al*. 1983) [2, 3]. While, occasionally, grain provides supplementary feed for productive animals. Animals improve soil fertility through manure and urine deposition and animal power for farm operations and transport. Sale of animals sometimes provides cash for farm labor and agricultural inputs.

Animals play key and multiple roles in the functioning of the farm, and not only because they provide livestock products (meat, milk, eggs, wool, and hides) or can be converted into prompt cash in times of need.

Table 6: Impact of different interventions on the yield and economics of farmers in a partially irrigated situation

Components of the farming system	Area (ha)	Details of interventions given during 2020-21	Main crop equivalent yield (kg ha^{-1})	Cost of cultivation (Rs ha^{-1})	Net Returns (Rs ha^{-1})	Employment generation (man-days)
Crop/Intercropping system						
Crop 1:Cotton+Soybean (1:1)	0.80	Opening of the furrow in each row at 30-35 DAS.	1750	44773	54973	93
Cotton +Soybean (1:1)		Spray of 2% 19:19:19 at pod initiation stage in soybean.	1877	45128	61810	93
Cotton +Soybean (1:1)		Protective irrigation	2100	45930	73710	93
Livestock (L) and number of animals						
L:1: Cow-01		Vaccination feeding of lucerne grass with concentrates and mineral mixture.	573 (milk Lit/year)	4775	11269	91
L:2: Bullock pair-01			55 (labour days/yr)	13200	17050	55

Table 7: Effect of interventions on the manpower generations

Cropping System	Total Man days labor involved per year
Sole Soybean	63
Soybean+ Pigeonpea	76
Sole Cotton	121
Sole Chickpea	61
Cotton+ Soybean	93
Labour requirement for rearing of livestock	
Cow	91
Buffalo	183
Goat	137

Lessons learnt: Integrated farming system need to be encouraged by

- Farm pond storage and its use efficiency should be accorded a priority in agricultural development along with supplementary or allied enterprises
- Networking of farmers on the basis of small and marginal land holding farmer should be developed which further proceed for the common farm enterprises should be promoted to make agricultural produce more productive and remunerative.
- During summer season off-farm some livelihood activities need to be promoted

Conclusion

From the study of village of Redwa, Akola it was concluded that only crop farming is not beneficial for the farmers, but along with farming livestock rearing is also important. State Department needs to play an important role as they have a major stake in the sustainable income of farmers.

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