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CLIMATE SMART INTEGRATED FARMING SYSTEMS MODEL FOR RESOURCE MANAGEMENT AND RURAL EMPLOYMENT IN VIDHARBHA REGION OF MAHARASHTRA

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ABSTRACT

Integrated farming systems model for livelihood security of farmers in Vidarbha region includes different components of crop + Fruit and Vegetable + Goat + Cow + Poultry + Compost + Organic kitchen garden + Apiary + Boundary plantation etc. with an objectives to increase component wise yield and income of the system, resource management for sustainability and to mitigate the climate change effect, value addition for post-harvest processing and employment generation for rural youth, need based diversification of components in IFS and to reduce carbon emission through crop components. Total rainfall of the season (22-52 MW) was 834.6 mm received within 42 rainy days. Irrigation water was applied to all crops under IFS model, during *rabi* season due to cessation of monsoon from 38th MW onwards.

One hectare integrated farming system irrigated model comprising cropping system (0.70 ha) + Horticulture (0.25 ha) + Livestock + compost (0.03 ha) + organic kitchen garden + others (0.02 ha) produced total seed cotton equivalent yield (48.57 q ha^{-1}), gross returns (Rs.2,39,080 ha^{-1}), employment generation (485 Man days annum), crop residues and manures (200 q), contributed nutrients addition of (381.45 kg), saves fertilizer cost (Rs. 10,033) and in addition of income model meet out various needs of family within farm and surplus for marketing.

(Key words : Integrated farming systems model, resource management, rural employment and cropping systems)

INTRODUCTION

The operational farm holding in India is still declining. In Bihar and Kerala, the average size of holding fell by more than three times during the last four decades, whereas in Andhra Pradesh, Karnataka, Madhya Pradesh and Maharashtra, it has reduced by more than two times due to immense population pressure on the limited land resource available for cultivation (Anonymous, 2014). The declining trend of capita^{-1} land availability poses a serious challenge to the sustainability and profitability of farming (Siddeswaran *et al*., 2012). Farming system approach introduces a change in farming techniques for higher production from the farm as whole with the integration of all the enterprises. The farm products other than the economic products, for which the crops are grown, can be better utilized for productive purposes in the farming system approaches. A judicious mix of cropping systems with associated enterprises like dairy, poultry, piggery, fishery, sericulture etc. suited to the given agro-climatic conditions and socio-economic status of farmers would bring prosperity to the farmer. Integrated farming systems model for livelihood security of farmers of *Vidarbha* includes Crop + Fruit and Vegetable + Goat + Cow + Poultry + Compost + Organic kitchen garden + Apiary + Boundary plantation etc. With the objectives the experiment was framed to increase component wise yield and income of the system, resource management for sustainability and to mitigate the climate change effect, value addition for post harvest processing and employment for rural youth, need based diversification of components in IFS and to reduce carbon emission through crop components.

MATERIALS AND METHODS

Experiment was conducted during year 2017-18 at the farm of IFSR unit Dr. PDKV, Akola.Total rainfall of the

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season (22-52 MW) was 834.6 mm received within 42 rainy days. This rainfall was surplus by 60.6 mm as against the average rainfall of 774 mm. Monsoon was practically ceased from 38th MW and there were no rains from 38th MW. Hence, onwards irrigation water was applied to all crops under IFS model, during *rabi* season . Details of crop and other enterprises included in the model are given in the table below.

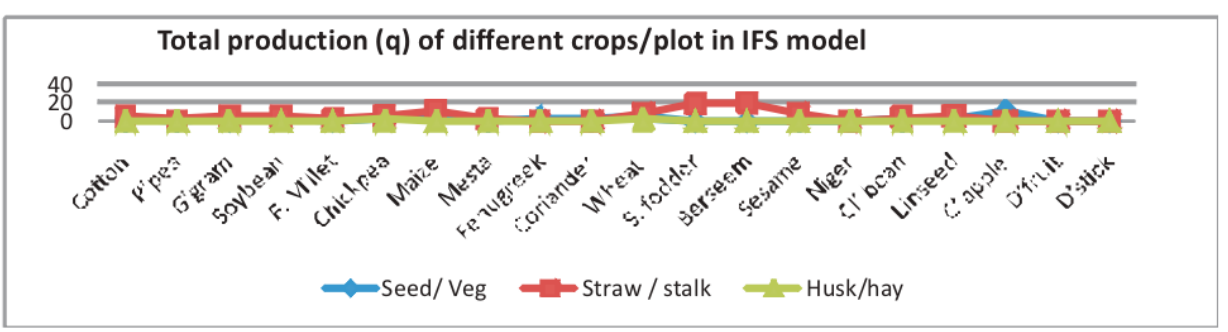
As per the need of five members of family, various components/ enterprises in IFS model are included and given in plan. The various crops, varieties and packages of practices were adopted as per the university recommendation. To check the possibility of new and diverse enterprises like dragon fruit and bee keeping were included for testing the feasibility to generate income and employment in IFS model.

Distribution of 1.00 ha area of IFS model under different components

Sr. No.	Components			Area in ha
A	**Cropping systems**			
	Kharif	***Rabi***	**Summer**	
1	*Deshi* Cotton (HDPS) + Pigeonpea (5:1) + Green gram in additive series	—	Cowpea	0.15
2	Soybean + Finger millets (1:1)	Chickpea	Cowpea	0.15
3	Maize + Mesta (2:1) – Fenugreek + Coriander (Trap crop) (2:2)	Wheat	Cowpea	0.15
4	Sorghum fodder	Berseem	Cowpea	0.05
5	Sesame(0.10 ha),Niger (0.05 ha) Clusterbean (0.05 ha)	Linseed	Cowpea	0.20
B	**Horticulture**			
6	Custard apple + Drumstick +Dragon fruit	—	—	0.25
C	**Livestock**			
7	Cow (Gir) + Goat (Berari 5 F+ 1 M) + Poultry + Compost + Shed			0.03
D	**Others**			
8	Kitchen garden			0.02
9	Bee keeping (Satpudi local) (Apiary)			
10	Boundary plantation of *Glyricidia*, *Karoanda, Hybrid Napier and Custard apple*			—

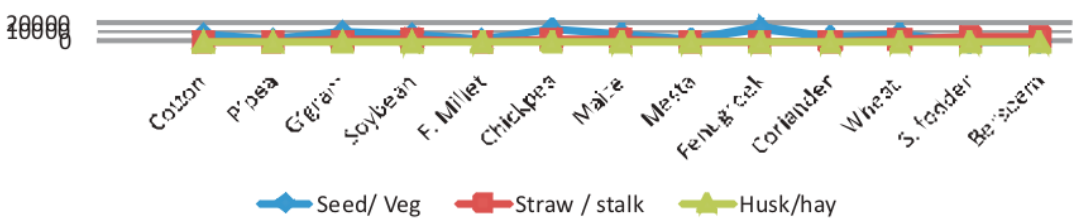
RESULTS AND DISCUSSION

Results of cropping systems revealed that the total grain yield (29.72 q), straw /stalk yield (102.88 q) and hay yield (3.89 q) recorded in cropping system from 0.70 ha area. Among all the cropping system tested under IFS model, maize based cropping system recorded highest seed/grain yield (15.54 q) followed by soybean based system (5.48). Whereas, stalk/straw yield was noted highest (37.50 q) in sorghum fodder – berseem – cowpea cropping system followed by maize system with 23.08 q straw / stalk yield and in case of husk or hay yield (1.69 q) recorded maximum in maize based system. Maize based system was found more remunerative among the others. Horticultural enterprise have recorded total seed/fruit/veg. yield (10.35 q) in Custard apple + Dragon fruit + Drumstick horticulture based system. Crop based farming system for hilly areas A micro-watershed based agro-pastoral system in a hilly slope holds promise for small and marginal farmers for sustaining their family and soil fertility on low input basis (Bhatt and Bujarbaruah, 2005).



Total gross monetary returns of cropping system was (Rs. 1,09,885) from the seed/grain/veg, straw/stalk (Rs. 19,779), hay (Rs. 1,866) and total receipt was Rs. 131,530 from 0.70 ha area of cropping system. Among the cropping system, total receipt of (Rs. 41,169) was recorded in maize based system followed by sesame based system (Rs.36,106) and lowest in sorghum fodder- berseem - cowpea cropping system (Rs. 7,500). More or less equal GMR was noticed in soybean based system (Rs. 25,510) and cotton based system (Rs. 21245). If we consider yield contributing component, the higher contribution in GMR was from seed/grain/veg. production and it was recorded highest (Rs. 36452) in maize based system nearly followed by sesame based cropping system (Rs. 34,210), soybean based system (Rs. 20860) and cotton based system (Rs. 18363). In case of horticulture component the total receipt was observed to be Rs. 41,400 from custard apple fruits block of IFS model (0.25 ha area). Singh *et al.* (2006) developed sustainable integrated farming system models for irrigated agro-ecosystem of eastern Uttar Pradesh of north-eastern plain zone which revealed that rice-pea-okra was the most remunerative cropping sequence with highest rice equivalent yield of 17.88 t ha^{-1} and net returns than the conventional rice-wheat sequence. This model generated significantly higher levels of employment than rice-wheat system.

Fig. 2. Gross monetary return (Rs) croping system and horticultural component in IFS model



It was observed that the total production of biomass (304.59 q) recorded through by products of cropping systems and manures (20.86 q) from livestock component in 1 ha. Out of which 125.54 q goes to feed the animals and remaining 179.08 q biomass becomes available for compost making. Among the various components, cropping system alone contributes highest production of total biomass (245.30 q) followed by others (21.47 q), livestock (20.86 q) and horticulture (16.96 q). The component like cropping system, horticulture and other contributed maximum biomass production through stalk (108.49 q), straw (70.07 q), stubbles (37.53 q) and leaf litter (20.71 q) and grasses collected from weeding in cropping systems. Livestock component contributes manures/composts through goats (10.96 q), cow (3.60 q) and poultry (6.30 q) respectively. Korikanthimath and Manjunath (2009) found that FYM and poultry manure influenced the soil to improve its fertility after successive rotation of different cropping systems (1.35%) as compared to no manure recycling. Recycling of paddy straw with mushroom substrate had an impact in retaining carbon status of soil (1.33%).

Two Berari goat (Does) weighing 44 kg live weight were earned Rs 9,900. Similarly total (10.86 q) goat manure were produced that amounting Rs. 4344 in the year and used in IFS model, particularly in organic kitchen garden, custard apple and boundary plantation. The cost incurred was Rs. 39450 included labour wages, concentrated feed and medicines etc. Yearly expenditure was more as compared to gross monetary returns, Hence, net profit recorded Rs. 25206 with 0.36 B:C ratio. But the expenditure of past year may convert into income after sale of goats/livestocks. The employment generated in goatary was 183 days $annum^{-1}$. Poultry unit, 58 birds weighing 55 kg live weight sold at Rs. 27,500. At the same time birds had produced manure @ 6.30 q amounting Rs. 3150/-. Thus, this unit have recorded the total income of Rs. 30,650/-. The expenditure made on purchase of chicks, labour wages and feeding the concentrate to the birds was 14,200/-. Hence, the net profit recorded was Rs. 16,450/- with highest B:C ratio (2.16) and employment generated round the year were 15 man days. In the backyard poultry unit, 58 birds were grown for 4 months to gain maximum weight and then weighing 55 kg amounting Rs. 27,500 with 6.30 q compost @ Rs. 3150. Thus, the profit came to Rs. 16450 with B:C ratio 2.16. The employment generated for 15 mandays $annum^{-1}$. Total 32 kadaknath poultry birds were kept for next year cycle. Kulkarni *et al.* (2014) conducted IFS in farmers' field of Raichur in Karnataka and found that integration of various components improved farm income in a sustainable manner besides reduction in cost of cultivation by adopting low cost and ecofriendly technologies. Pearl millet followed by groundnut was common cropping practice followed by the farmer. By adoption and integration of various components like vegetable (tomato, brinjal, chilli, bottlegourd, ridgegourd, coriander, methi, etc), cow, poultry birds, fishery, vermicomposting, Panchagavya, Jeevamruth etc., there was sustainable increase in net returns, i.e. 243.3% over pearl millet– groundnut cropping system (Rs. 23450). There was also drastic reduction in cost of cultivation besides generating more employment, i.e. 245-man days in IFS demonstration as against 80-man days in normal practice.

Details of livestock components in IFS Model

Total income generated from 2 goat animals and 58 poultry birds weighing 99.0 kg and producing 20.76 q manures in the livestock enterprises recorded the receipt of Rs. 46,334 with expenditure of Rs. 56,650 and net profit of Rs. (-) 10,316. The average B:C ratio recorded was 0.82 and employment generation of 213 man days round the year. In North Telangana zone, farming system with agriculture and dairy generated more than 200 % additional employment over agriculture alone. The net returns were higher in agriculture and dairy followed by agriculture and poultry and agriculture and sheep (Reddy 2005). Crop-livestock-poultry farming system: Ramrao *et al*. (2006) studied crop-livestock integrated farming system for the marginal farmers in rainfed regions of Chhattisgarh in Central India to find out a sustainable mixed farming model which is economically viable integrating the different component like crop, livestock, poultry and duck on 1.5-acre land holding. A model having 2 bullocks + 1 cow + 1 buffaloes + 10 goats + 10 poultry + 10 ducks along with crop cultivation was the best with a net income of Rs. 33076 year^{-1} against arable farming (crop farming).

Biomass turned to compost and their contribution into addition of nutrients in 1.00 ha IFS model

The total weight of compost material recorded (200 q) and that contributed nitrogen (130 kg), phosphorus (60 kg), potash (141 kg) and calcium (50 kg) total comes to 381 kg. Out of which cropping systems (including stalk, leaf litter, root/stubbles, grasses and other field wastes) recorded maximum weight of crop residues (179.08 q) and contributed nitrogen (77 kg), phosphorus (38 kg), Potash (87 kg) with no calcium total comes to 202.16 kg of NPK through compost. Whereas, the livestock manure weighing 20.86 q contributed nitrogen (53.11 kg), phosphorus (21.73 kg), potash (141 kg) and calcium (50 kg) total comes to 179.29 kg through goat, cow and poultry manure which enrich the soil. It constituted an additional income of Rs. 17908 (crop residues) and Rs. 8344 (manure) with an addition of nutrients to soil (Rs. 1870). Thus, cost of fertilizers nutrient purchase can be saved. Thus, the values of biomass and nutrients comes to (Rs. 36,285 ha^{-1}). In integrated crop livestock farming system, crop residues can be used for animal feed, while manure from livestock can enhance agricultural productivity by intensifying nutrients that improve soil fertility as well as reducing the use of chemical fertilizers (Gupta *et al.,* 2012). Animal excreta contain several nutrients (including nitrogen, phosphorus and potassium) and organic matter, which are important for maintaining the soil structure and fertility. Bhatt and Bujarbaruah (2005) and Kumar *et al*. (2011) emphasized that the wastes/by-products of crop/animals used as input for another component has increased the nutrient efficiency at the farm level through nutrient recycling . Integration of crop sequences with animal component improved the system portability in totality even on small farm of 0.50 ha having 32% slope (converted into terraces) at Umiam, Meghalaya, which contributed more than 55% of the total farm income and made the system more remunerative (Panwar, 2014). The inclusion of animal component in the system set a positive link on sustainability by generating cash income, improving family nutrition and recycling crop residues and livestock refuse into valuable nutrient source for crops (Saxena *et al*., 2003).

One hectare irrigated integrated farming system model comprising cropping system (0.70 ha) + Horticulture (0.25 ha) + Livestock + compost (0.03 ha) + Others (0.02 ha) produced total seed cotton equivalent yield (48.57 q ha^{-1}), gross returns (Rs.2,39,080 ha^{-1}), NMR(Rs. 18,696), B: C ratio (1.08), employment generation (485 Man days), crop residues and manures (200 q), contributed nutrients addition of 381.45 kg, saves fertilizer cost (Rs. 10,033) and in addition of income model meet out various needs of family within farm and surplus for marketing.

Table 1. Total biomass and manure production (q) in 1.00 ha IFS model

Sr. No.	Components	Stalk	Straw /Husk/ hay	Leaf litter	Stubb-les	Total Biomass	Biomass for animal	Biomass for compost
A) Cropping System								
1.	*Deshi* Cotton (HDPS) + Pigeonpea (5:1) + Green gram in additive series- Cowpea*	11.20	12.30	2.08	5.62	31.19	14.22	16.97
2.	Soybean + Finger millets (1:1) – Chickpea – Cowpea*	14.29	10.44	2.16	4.43	31.33	13.81	17.52
3.	Maize + Mesta (2:1) – Fenugreek - Coriander (Trap crop) (2:2)– Wheat – Cowpea*	25.59	11.31	1.99	9.99	95.81	24.88	70.96
4.	Fodder jowar + Berseem – Cowpea*	37.50	5.08	0.85	4.09	47.52	43.43	4.09
5.	Sesame+Niger+Cluster bean-Linseed-Cowpea	18.87	13.53	1.87	5.18	39.45	11.43	28.02
Total (A)cropping system		107.45	52.66	8.95	29.31	245.30	107.77	137.56
B) Horticulture								
6.	Custard apple + Dragon Fruit plantation	———	6.35	9.78	0.83	16.96	6.35	10.61
	Total (B) Horticulture	———	6.35	9.78	0.83	16.96	6.35	10.61
C) Others								
7.	Kitchen garden	0.80	0.62	0.30	0.53	2.25	0.62	1.63
8.	Flowers	0.24	0.37	0.33	0.86	1.80	0.37	1.43
9.	Boundary Plantation	——	7.53 (GF)	0.99	——-	8.52	7.53	0.99
10.	*Hy.Napier (GF)*	———	2.54	0.36	6.00	8.90	2.90	6.00
	Total (C) Others	1.04	11.06	0.98	0.39	21.47	11.42	10.05
Total in all (A+B+C)		108.49	70.07	20.71	37.53	283.73	125.54	158.22
D) Livestock								
11.	i) Goat	—	—	—	—	10.96	—	10.96
12.	ii) Poultry	—	—	—	—	6.30	—	6.30
13.	iii) Cow	—	—	—	—	3.60	—	3.60
14.	iv) Bee keeping	—	—	—	—	—	—	—-
Total (D) Livestock						20.86		20.86
Total in all (A+B+C+D)		**108.4**	**70.07**	**20.71**	**37.53**	**304.59**	**125.54**	**179.08**

Table 2 . Details of livestock components in IFS Model

Livestock	No (s)	Live wt (kg)	GMR	Weight of manures (q)	GMR cost (Rs)	Total GMR (Rs.)	Cost of input (Rs)	Total NMR (Rs.)	B:C ratio	Man days
Goatary (Berari)	2	44	9900	10.86	4344	14244	39450	-25206	0.36	183
Poultry(Kadaknath)	58	55	27500	6.30	3150	30650	14200	16450	2.16	15
Cow (1)(Gir)	—	—	—	3.60	1440	1440	3000	-1560	0.48	15
Total	60	99	37400	20.76	8934	46334	56650	-10316	0.82	213

Table 3 . Component wise biomass turned to compost and their contribution into addition of nutrients in 1.00 ha IFS model

Component	Wt. of compostable biomass (q)	Contribution to nutrients (kg ha^{-1})				
A) Cropping system		N	P	K	Ca	Total
All crops in IFS system including (leaf litter, stubbles, grasses & other farm wastes)	179.08 (Rs.17908)	— 77.19	— 38.00	— 86.97	— —	— 202.16
Total (A) Cropping systems @ Rs. 100 q^{-1}	179.08	77.19	38.00	86.97	—	202.16
B) Livestock						
Goatary	10.96	23.02	6.03	27.95	17.54	74.54
Cow	3.60	20.11	8.60	26.00	12.90	67.61
Poultry	6.30	9.98	7.10	—	20.06	37.14
Livestock Total (B) @ Rs. 400 q^{-1}	20.86(8344)	53.11	21.73	53.95	50.50	179.29
Grand Total (A+B)	199.94	130.30	59.73	140.92	50.50	381.45
Market cost (Rs.)(A+B)	26,252	1697	2987	2824	2525	10,033

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