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CLIMATE RESILIENT INTERCROPPING SYSTEMS FOR RAINFED MEDIUM BLACK SOILS OF AKOLA DISTRICT IN VIDARBHA REGION OF MAHARASHTRA

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Abstract: *The assessment studies on different intercropping systems alongwith their respective sole crops were implemented with active participation of farmers in Warkhed village of Akola district of Maharashtra during 2014-15 to 2016-17 as a part of National Initiative on Climate Resilient Agriculture Project (NICRA). The main objectives of study were to popularized climate resilient rainfed intercropping system in medium black soil to mitigate climate variability. Intercropping of soybean + pigeonpea (4:2) and cotton + greengram (1:1) were identified as best climate resilient system in medium black soil of Vidharbha inAkola district of Maharashtra. Soybena + pigeonpea (4:2) intercropping system, on an average enhanced soybean equivalent yield by 2138 kgha^{-1}, NMR Rs. 41652 ha^{-1}, B:C ratio 2.42 and cotton + greengram (1:1)intercropping system enhanced cotton equivalent yield by 1765 kg ha^{-1}, NMR Rs. 42578 ha^{-1} and B:C ratio 2.30. These higher yield recorded 50.79 & 21.81 % of yield and 78.33 & 35.15 % NMR advantage than sole crop of soybean and cotton.In Akola district of Maharashtra soybean + pigeonpea (4:2)and cotton + greengram (1:1)were identified as climate resilient intercropping system. Hence, adoption of intercropping system in rainfed medium black soil is climate resilient system and also help in improving food security in rainfed area.*

Key words: *Climate resilient intercropping system, rainfed medium black soils of akola, intercropping system.*

Introduction

Rainfed agriculture which constitutes nearly 58% of net cultivated area will be the most impacted. Crop production in the rainfed lands in India is presently having numerous problems like insufficient and erratic rainfall land degradation and low soil fertility, poor supply of agricultural inputs, poor technology dissemination system, low investment capacity of farmers etc. Further it is strongly believed that climate change will further exuberate the problems of rainfed agriculture. The vulnerability of rainfed lands climate change and variability has been exposed by the effect of recent floods and prolonged drought in different parts of the country. Therefore, it is of most importance to enhance resilience of rainfed agriculture to climate change through planned adoption of appropriate inter/sequence cropping system and also with other management practices of natural resource management (Singh *et al.* 2009).

Intercropping is an important aspect than sole cropping to address the issues of rained agriculture under changing climate scenario and it also helps in the maximization of productivity and profitability by efficient utilization of natural resources like land, light and water (Chandra *et al* 2010). Inclusion of legumes as intercrops in fiber and oilseed crop as based intercropping sequence would have a positive effect on the productivity, economics and fertility status of the soil. Keeping this in view an attempt was made to evaluate different fibre/oilseed/pulses based intercropping systems to bring stability in productivity and profitability against climate risksin selected village of Vidharbha region of Maharashtra state.

Material and Methods

The steps followed in selection of sites in districts include analysis of climate constraints of village based on long term data assessment of natural resources, identification of major faming situations, constraints of crop production, climate

vulnerabilities, yield gaps and opportunities for climate change adaptations based on the detailed analysis, action plan to demonstrate appropriate intercropping systems to meet climate vulnerability (drought) was prepared on participatory mode with the help of scientists and farmers. The demonstrations were implemented during *Kharif* 2014-15, 2015-16, 2016-17 and 2017-18.

The farmers in the selected village of Akola district was stratified based on size of holding into marginal (>1ha), small (1-2 ha), medium (2-4 ha) and large farmers (>4 ha). The training programs on production skills of different crops/intercropping system were imparted to the participants before conducting the demonstrations. The details of villages selected for the purpose of study along with the soil types and normal rainfall climate vulnerabilities faced by the farming communities. The demonstrations on the improved intercropping systems along with the sole crops were conducted in 0.40 ha area on each farmers site in selected village (Table 1).

After the harvesting of intercrops, the yield of intercrops was recorded and residues of intercrops i.e. greengram and soybean are mulched in cotton and pigeonpea crops. The economic analysis of inputs and output relationship and grain equivalent yield were worked out to quantify the benefits of interventions for last five years. Equivalent yield for each intercropping system was calculated based on the yield of individual crops in each intervention and their market prices prevailing at the time of experimentation for comparison of intercropping system with sole crop.

Table 1: Area, number of farmers and rainfall under different intercropping systems

Village	Cropping system and Varieties	Year	Area (ha)	Number of farmers	Rainfall		
					N	A	Cropping season
Village WarkhedTaluka-Barshitakli, District- Akola	Soybean+Pigeonpea(4:2) Soybean+Pigeonpea(6:1) Sole Soybean Soybean-JS-335 Pigeonpea- PKV Tara	2015-16	6.40	16	778.5	644.6	644.6
		2016-17	6.40	16	778.5	832.3	811.8
		2017-18	7.20	18	778.5	492.6	429.9
			20.00	**50**			
Village Warkhed, Taluka-Barshitakli, District- Akola	Cotton+Greengram (1:1), Sole Cotton *Bt.* Cotton–Malika Greengram - Utkarsha	2014-15	2.80	07	778.5	691.3	670.1
		2015-16	2.80	07	778.5	644.6	644.6
		2016-17	2.80	07	778.5	832.3	811.8
		2017-18	4.80	12	778.5	492.6	429.9
			13.20	**33**			

Rainfall pattern at experimental sites

The village Warkhed (Bk) in Barshitakli taluka of Akola district of Maharashtra State is situated between 77^{O}7' 00" to 77^{O} 10' 00" E longitude and 20^{O} 32' 30" to 20^{O} 35' 00" N latitude and covers area of 198 ha. The mean elevation of the area is about 325 m above MSL. It is about 32 km south-east of Akola city. Villages receives normal rainfall of 807.0 mm. The villages normally receive an average rainfall of 707.22 mm rainfall during the cropping season estimated from the rainfall received during last four years i.e 2014-15, 2015-16, 2016-17 and 2017-18. The rainfall in the villages was 691.3,644.6,832.3 and 492.6 mm which was less than normal rainfall by 87.2, 133.9, +53.8 and 285.9 mm during the year 2014-15, 2015-16, 2016-17 and 2017-18, respectively. During the year 2014-15 the total rainfall received is very low and sowing of the *Kharif* crops were taken up in the 2nd week of July.

Results and Discussion

Assessment of intercropping systems of soybean+pigeonpea and cotton+greengram (1:1) were done with active participation of 50 and 33 farmers in 20 and 13.2 ha area in medium black soils

of Warkhed village, Taluka – Barshitakali and Dist-Akola in Maharashtra state.

During the year of 2015-16 to 2017-18 , the results showed that intercropping of soybean+pigeonpea (4:2) recorded higher soybean equivalent yield 2164, 2218 and 2034 kg ha^{-1} compared to the soybean+pigeonpea (6:1) 1785, 1884, and 1758 kg ha^{-1} and sole crop which recorded 831, 1202, and 1123 kg ha^{-1}. On an average the intercropping system of soybean+pigeonpea (4:2) significantly enhanced the soybean equivalent yield 2138 kg ha^{-1} and B:C ratio of 2.42. Soybean+piegeonpea in row proportion of (6:1) and sole soybean significantly enhance the soybean equivalent yield which was 1809 and 1052 kg ha^{-1} and B:C ratio of 1.94 and 1.26.

Lakhena and Maurya (2009) and Turkhede *et al.* (2015) reported that, intercropping system reduced the yield of main crop and significantly increase the grain equivalent yield over sole crop. Reddy *et al.* (2015) reported that the, soybean+ pigeonpea system gave benefit to the extent of 40-60 percent in different sites of Kurnool in Andhra Pradesh, Aurangabad and Nandurbar districts of Maharashtra.

Table 3: Productivity and profitability of intercropping system of soybean +pigeonpea in mediumblack soils of Akola, Maharashtra

Year	Cropping System	Grain Yield (Kg ha^{-1})		Grain Equivalent Yield (Kg ha^{-1})	NMR (Rs.ha^{-1})	B:C Ratio
		Soybean	Pigeonpea			
2015-16	Sole Soybean		-	831	10246	1.14
	Soybean+Pigeonpea (4:2)			2164	60792	3.09
	Soybean+Pigeonpea (6:1)			1785	43087	2.29
2016-17	Sole Soybean		-	1202	7788	1.28
	Soybean+Pigeonpea (4:2)			2218	34656	2.17
	Soybean+Pigeonpea (6:1)			1884	24835	1.83
2017-18	Sole Soybean		-	1123	9042	1.38
	Soybean+Pigeonpea (4:2)			2034	29508	2.00
	Soybean+Pigeonpea (6:1)			1758	21349	1.72
Mean	**Sole Soybean**		**-**	**1052**	**9025**	**1.26**
	Soybean+Pigeonpea (4:2)			**2138**	**41652**	**2.42**
	Soybean+Pigeonpea (6:1)			**1809**	**29757**	**1.94**

In cotton + greengram intercropping system, cotton equivalent yield and B:C ratio were higher by 1357, 1885, 2365 and 1452 kg ha^{-1} and3.31,2.37,2.11 and 1.42 over sole cotton during 2014-15, 2015-16, 2016-17 and 2017-18 respectively. On an average, cotton equivalent yield and B:C ratio recorded higher values on cotton + greengram in row proportion of (1:1) which are 1765 and 1380 Kg ha^{-1} and 2.30 and 1.91, respectively. Any short duration intercrop used in the system will pay farmer and much needed interim income or meet the domestic requirement of food and fodder also reported by the Rao (1991), Patel *et al.* (2013) and Kumar *et al.* (2017).

Table 4: Productivity and profitability of intercropping system of cotton + greengram (1:1) in medium black soils of Akola, Maharashtra

Year	Cropping System	Yield (Kg ha^{-1})		Cotton Equivalent Yield (Kg ha^{-1})	NMR (Rs.ha^{-1})	B:C Ratio
		Cotton	Greengram			
2014-15	Sole Cotton		-	1157	36463	2.82
	Cotton + Greengram (1:1)			1357	42767	3.31

2015-16	Sole Cotton		-	1485	34731	1.95
	Cotton + Greengram (1:1)			1885	52361	2.37
2016-17	Sole Cotton		-	1742	28689	1.62
	Cotton + Greengram (1:1)			2365	54761	2.11
2017-18	Sole Cotton		-	1134	10558	1.24
	Cotton + Greengram (1:1)			1452	20424	1.42
Mean	**Sole Cotton**		-	**1380**	**27610**	**1.91**
	Cotton+Greengram (1:1)			**1765**	**42578**	**2.30**

Conclusion:

The assessment studies on intercropping system in black soil of Akola districts of Maharashtra, indicated that soybean + pigeonpea (4:2) and cotton + greengram (1:1) were found more stable than sole crops of soybean and cotton under climate resilient in rainfed environment. Thus, intercropping offers solution to obtained higher yield per unit area, diversified food and reduced risk of crop failure under rainfed condition.

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