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Evaluation of cropping systems for the coastal deltaic region of Karaikal

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Abstract : Field experiments were conducted at the farm lands of Pandit Jawaharlal Nehru College of Agriculture & Research Institute, Karaikal during *kharif,* 2003 and 2004 in order to design an appropriate alternate cropping system for Karaikal region of Union Territory of Pondicherry to meet the exigency of water scarcity and to boost the income of the farmers on sustainable basis. The first year of field experiment (2003 – '04) was conducted during *kharif* season in a split plot design with four ID crops *viz.* 'CO7' pearl millet, 'CO27' forage sorghum, 'TMV3' sesame and 'Palur 1' brinjal under two amendments *viz.* FYM @ 12.5 t ha^{-1} and gypsum @ 100 per cent neutralization of RSC of water along with an unamended control. During second year (2004 - '05), the *kharif* experiment was studied in split -split plot design with two more additional crops *viz.* 'CO (S) 28' grain sorghum and 'CO1' maize, one additional amendment *i.e.* gypsum at 50 per cent neutralization of RSC and another additional factor as foliar spray at two levels *i.e.* foliar spray treatment with 2% DAP + 1% KCl and a control. The highest Rice Yield Equivalent (RYE) was realized with brinjal (7852 kg ha^{-1}) and grain sorghum (4544 kg ha^{-1}) and similarly the total system productivity was the highest in brinjal - rice (12736 kg ha^{-1}) and grain sorghum - rice (9249 kg ha^{-1}) during 2003-'04 and 2004–'05, respectively. The additional expenditure above the existing system of fallow - rice was higher in brinjal - rice sequence (Rs. 14589 ha^{-1}) and at the same time additional returns from that sequence was also higher (Rs. 31899 ha^{-1}) than other crop sequences under study during 2003-'04. However, during 2004-'05, grain sorghum - rice registered more net gain of Rs. 6132 ha^{-1} than others. In all the double crop systems under study, application of FYM had proved its economic viability by registering higher net gain than other amendments. However, application of inorganic amendment (gypsum) either at 50 per cent or 100 per cent neutralization of RSC of water was not found to be economically remunerative more particularly to pearl millet, forage sorghum, maize and sesame.

Key words: Cropping sequence, cropping system, amendment gypsum, return.

Introduction

Indian agriculture has gone through a sea change in the past 50 years. As knowledge progressed, new technologies developed and rate of growth in agriculture increased, the cropping system research also under went various stages of evolution. Designing of efficient cropping systems for different agro - ecological situations and farm resource base became the major plank of cropping systems research (Yadav *et al.,* 1998).

The coastal ecosystem, representing 5.5 per cent of the total geographical area of India is endowed with rich natural resources. The coastal areas are categorized as high potential areas. In India, the coastal belt stretches to about 7517 km (Kadrekar, 1994),

Table 1. Rice Yield Equivalent (RYE), Rice yield and Total system production of the proposed cropping system under different set of amendments

System		2003 - 2004				2004 - 2005		
		RYE	Rice yieid	Total		RYE	Rice yield	Total
Pearl millet - Rice	A_0	3662	5467	9129	A_0	2290	4583	6873
	A_1	4192	6187	10379	A_1	3512	5000	8512
	A_2	3754	5615	9369	A_2	2826	4583	7409
					A_3	2890	4583	7473
Mean		**3869**	**5756**	**9626**		**2880**	**4687**	**7567**
Forage sorghum - Rice	A_0	3554	5844	9398	A_0	2922	4653	7575
	A_1	3901	6092	9993	A_1	3822	4722	8544
	A_2	3753	5496	9249	A_2	3056	4583	7639
					A_3	3333	4792	8125
Mean		**3736**	**5811**	**9547**		**3283**	**4688**	**7971**
Grain sorghum - Rice	A_0	-	-	-	A_0	3662	5069	8731
	A_1	-	-	-	A_1	5199	4722	9921
	A_2	-	-	-	A_2	4304	4653	8957
					A_3	5010	4375	9385
Mean		**-**	**-**	**-**		**4544**	**4705**	**9249**
Maize - Rice	A_0	-	-	-	A_0	2929	4653	7582
	A_1	-	-	-	A_1	3733	4653	8386
	A_2	-	-	-	A_2	3467	4375	7842
					A_3	3539	4583	8122
Mean		**-**	**-**	**-**		**3417**	**4566**	**7983**
Sesame - Rice	A_0	3276	5825	9101	A_0	2787	4653	7440
	A_1	3391	6421	9812	A_1	3667	4792	8459
	A_2	3369	6125	9494	A_2	2751	4653	7404
					A_3	3222	4445	7667
Mean		**3345**	**6124**	**9469**		**3107**	**4636**	**7743**
Brinjal - Rice	A_0	8143	4862	13005	A_0	3208	4583	7791
	A_1	9142	4814	13956	A_1	4070	4653	8723
	A_2	6241	5005	11246	A_2	3499	4792	8291
					A_3	3737	4792	8529
Mean		**7842**	**4894**	**12736**		**3629**	**4705**	**8334**

A_0 - No amendment; A_1 - FYM @ 12.5 t ha^{-1} & A_2 - 100% neutralization of RSC (2003 - '04)

A_0 - No amendment; A_1 - FYM@ 12.5t ha^{-1}; A_2 50% neutralization of RSC & A_3 - 100% neutralization of RSC (2004 - '05)

particularly, in Tamil Nadu and Pondicherry, it stretches to 1000 km in the east coast region. In Tamil Nadu, the coastal area alone spreads over 6,80,622 ha constituting 26.8 per cent of the total area of the coastal districts. Similarly, an area of 25,600 and 13,000 ha lies in the coastal regions of Pondicherry and Karaikal, respectively.

Karaikal, an enclave of the Union Territory of Pondicherry is situated at the tail end of the river Cauvery with typical coastal eco system. With augmented and controlled supply of water from the Mettur reservoir, rice was cultivated during both the seasons *viz., Kharif (Kurvvai)* (June -September) and *rabi (Thaladi)* (October - January) followed by a rice fallow pulses (January-February) as a conventional cropping sequence until two decades back. However, in recent times, owing to uncertainty in canal water supply for irrigation and poor quality of the irrigation water from the bore wells, cultivation of rice crop during *kharif* becomes a risky proposition at the region. There had been a gradual shift from double crop to single crop of rice leaving the fields mostly fallow during *kharif* season.

Therefore, designing an appropriate alternate cropping system for Karaikal region to meet the exigency of water scarcity and to boost the income of the farmers on sustainable basis becomes imperative. The crop selection is the foremost and appropriate management option for using poor quality irrigation water available from underground sources during *kharif* season. Similarly, the success of saline or sodic irrigation for increasing productivity mainly depends on the efficient control of salt water balance within the crop root zone. One of the management practices for managing the irrigation waters having high RSC is the application of amendments like gypsum (Bajwa *et al.,* 1993 and Minhas and Dubey, 1998) and organic amendments like FYM (Minnas and Dubey, 1998).

Materials and Methods

Field experiments were conducted at the farm lands of Pandit Jawaharlal Nehru College of Agriculture & Research Institute, Karaikal, U. T. of Pondicherry during *kharif* 2003 and 2004. The soil of the experimental field during first and second year was sandy loam and sandy clay in texture. The soils of both the years are low in available N and high in available P and K. The ESP of both the experimental soil was 16.9 and 12.4 per cent, respectively. The ground water used for irrigation was analyzed for its chemical composition during every month for calculating the Residual Sodium Carbonate as suggested by Eaton (1950). Based on the RSC of the irrigation water for that month, gypsum was calculated on plot basis for the irrigation water quantity applied at every irrigation by using the following equilibria: One milli-equivalent of pure gypsum (0.086 g) is required to neutralize one milli-equivalent of RSC in one litre of water

The first year of field experiment (2003 - '04) was conducted during *kharif* season in a split plot design with four Irrigated Dry (ID) crops *viz.* pearl millet (CO7), forage sorghum (CO27), sesame (TMV3) and brinjal (Palur 1) under two amendments *viz.* FYM @ 12.5 t ha^{-1} and gypsum @ 100 per cent neutralization of RSC of water along with an unamended control. During second year (2004 - '05), the *kharif* experiment was studied in split -split plot design with two more additional ID crops *viz.* grain sorghum (CO (S) 28) and maize (CO1), one additional amendment *i.e.* gypsum at 50 per cent neutralization of RSC and another additional

Table 2. Partial budgeting of the proposed cropping system under different set of amendments for the use of poor quality irrigation water.

System		2003 - 2004 Added cost	Added returns	Net gain		2004 - 2005 Added cost	Added returns	Net gain
Fallow - Rice		-	-	-		-	-	-
Pearl millet - Rice	A_0	10168	15669	5501	A_0	11788	9941	(-) 1847
	A_1	13168	21294	8126	A_1	14788	17316	2528
	A_2	14225	16479	2524	A_2	14775	12353	(-) 2422
					A_3	17761	12641	(-)5120
Mean		**12520**	**17904**	**5384**		**14778**	**13063**	**(-) 1715**
Forage sorghum - Rice	A_0	11296	16880	5584	A_0	12316	13100	7X4
	A_1	14296	19557	5261	A_1	15316	17460	2144
	A_2	16950	16209	(-)741	A_2	15303	13388	(-)1915
					A_3	18289	15575	(-) 2714
Mean		**14181**	**17549**	**3368**		**15306**	**14881**	**(-) 425**
Grain sorghum- Rice	A_0	-	-	-	A_0	11509	18302	6793
	A_1	-	-	-	A_1	14509	23657	9148
	A_2	-	-	-	A_2	14496	19319	4823
					A_3	17482	21245	3763
Mean		**-**	**-**	**-**		**14499**	**20631**	**6132**
Maize - Rice	A_0	-	-	-	A_0	12898	13131	233
	A_1	-	-	-	A_1	15898	16749	851
	A_2	-	-	-	A_2	15885	14301	(-) 1584
					A_3	18871	15561	(-) 3310
Mean		**-**	**-**	**-**		**15888**	**14934**	**(-)954**
Sesame - Rice	A_0	8884	15543	7177	A_0	10504	12492	1988
	A_1	11884	18743	6760	A_1	13504	17078	3574
	A_2	10087	17312	6806	A_2	12689	12330	(-) 359
					A_3	14874	13514	(-)1360
Mean		**10285**	**17199**	**6914**		**12893**	**13854**	**961**
Brinjal - Rice	A_0	12874	33111	20237	A_0	13294	14072	778
	A_1	15874	37391	21517	A_1	16294	18266	1972
	A_2	15018	25196	10178	A_2	14738	16322	1584
					A_3	16181	17393	1212
Mean		**14589**	**31899**	**17310**		**15127**	**16513**	**1386**

A_0 - No amendment; A_1 - FYM @ 12.5 t ha^{-1} & A_2 - 100% neutralization of RSC (2003 - '04)

A_0 - No amendment; A_1 - FYM@ 12.5t ha^{-1}; A_2 50% neutralization of RSC & A_3 - 100% neutralization of RSC (2004 - '05)

factor of foliar spray at two levels *i.e.* foliar spray treatment with 2% DAP + 1% KCl and a control.

Results and Discussion

Rice Yield Equivalent (RYE)

The highest RYE was realized with brinjal during 2003 - '04 (7852 kg ha^{-1}) due to higher yield and sale price of brinjal. The pearl millet, forage sorghum and sesame recorded 3869, 3736 and 3345 kg ha^{-1} of RYE, respectively. Similarly, the total system productivity was the highest in brinjal - rice (12736 kg ha^{-1}). However, during 2004-'05, the highest RYE was registered by grain sorghum (4544 kg ha^{-1}). The other ID crops *viz.* pearl millet, forage sorghum, maize, sesame and brinjal registered 2880, 3283, 3417, 3107 and 3629 kg ha^{-1}, respectively. Similarly, the grain sorghum - rice system had out yielded all other systems (Table 1) in terms of system productivity by registering 9249 kg ha^{-1}. During the second year of experiment without much distribution of rainfall, the crops under study mostly depend on poor quality irrigation water and hence, the RYE had substantially decreased when compared to the first year. However, even under such conditions grain sorghum more or less maintained the RYE of the first year average while all other systems failed to maintain the same. Since, the brinjal duration had been shortened to fit in the cropping system during the second year; the RYE was also lesser with brinjal - rice sequence.

Partial budgeting

The existing cropping practice of the region that has been widely adopted is fallow - rice during *kharif* and *rabi* seasons, respectively. However, this study had been conducted to intensify the system by utilizing the fallow *kharif* season for growing ID crops with the help of the poor quality under ground water. The economics of the individual crops could provide information on the cost involved and the returns obtained but would not provide information on the comprehensive picture.

For this purpose, the average cost of cultivation and the returns obtained from the rice crop alone that was tested in the study had been taken as the base line. The additional costs involved and returns obtained above this base line to adopt the proposed cropping system with amendment were computed. The added cost, added returns and net gain or loss of the proposed double crop sequences under different amendments compared to the single rice crop were worked out and presented in Table 2.

The additional expenditure was higher in brinjal - rice sequence (Rs. 14589 ha^{-1}) and at the same time additional returns from the sequence was also higher (Rs. 31899 ha^{-1}) than other crop sequences under study during 2003 - '04. Among the field crops (except vegetable), the net gain of sesame - rice (Rs. 6914 ha^{-1}) sequence was higher. Gypsum application for 100 per cent neutralizing the RSC of water was not found to be economically viable as the net gain obtained with the treatment was lower, even less than unamended control in all crop sequences except sesame - rice during 2003 - '04. In forage sorghum - rice sequence, application of gypsum had even resulted in a loss (Rs. -741 ha^{-1}) due to the higher added cost. During the second year (2004 – '05) of investigation with two more field crops included in the study, the additional expenditure was highest in maize - rice sequence (Rs. 15888 ha^{-1}) and it was the lowest in sesame - rice sequence (Rs. 12893 ha^{-1}). The added return due to double crop sequence was substantially higher in grain sorghum - rice (Rs. 20631ha^{-1}) and brinjal

- rice (Rs. 16513 ha^{-1}) than others. The lowest added return was registered by pearl millet - rice sequence (Rs. 13063 ha^{-1}). All the double crop sequences during 2004 - '05 had net loss except grain sorghum - rice, brinjal - rice and sesame -rice sequences which registered a net gain than single crop of rice. Among the systems tried, grain sorghum - rice registered more gain of Rs. 6132 ha^{-1} than others, followed by brinjal - rice (Rs. 1386 ha^{-1}) and sesame- rice (Rs. 961 ha^{-1}).

In all the six double crop systems under study during 2004 - '05, application of FYM had proved its economic viability by registering higher net gain than other amendments. However, application of inorganic amendment (gypsum) either at 50 per cent or 100 per cent neutralization of RSC of water was not found to be economically remunerative more particularly to pearl millet, forage sorghum, maize and sesame as their impact resulted in net loss as a result of higher additional cost.

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