International Journal of Science, Environment and Technology, Vol. 5, No 3, 2016, 1100 – 1107

ISSN 2278-3687 (O)
2277-663X (P)

SUSTAINABLE PRODUCTIVITY AND PROFITABILITY OF DIVERSIFIED RICE-BASED CROPPING SYSTEMS UNDER SOUTH GUJARAT CONDITION

L.J. Desai, J.D. Thanki, N.N. Gudadhe and R.M. Pankhaniya
Farming System Research, Department of Agronomy, N.M. College of Agriculture, Navsari Agricultural University, Navsari- 396 450 (Gujarat)
E-mail: ljdesai.sdau@yahoo.com

Abstract: A field experiment was conducted during 2007-08 to 2011-12 at Farming System Research Farm, Navsari Agriculture University, Navsari on clayey soil, having 7.8 pH, organic carbon 0.59 %, available nitrogen 194 kg/ha, P 18.2 kg/ha and K 153 kg/ha to evaluate the sustainable productivity and profitability of diversified rice-based cropping systems under south Gujarat condition. Ten Rice based cropping systems were evaluated for production potential in randomized block design with three replications. In pooled results, treatment T_6: Rice -sorghum (G) –sorghum ratoon (G) recorded significantly higher paddy equivalent yield (13488 kg/ha) which was at par with treatment T_3 (13095 kg/ha), T_9 (12463 kg /ha), T_7 (12379 kg/ha) and T_2 (12273 kg/ha). The minimum PEY (7866 kg/ha) were recorded under T_1: Rice- wheat: fallow in all experimental years as well as in pooled. Highest net return/ha was recorded in treatment T_6: Rice-sorghum (G) – ratoon sorghum (G) *i.e.* Rs. 97,567 /ha followed by T_7 (Rs. 84,102 /ha) and T_2 (Rs. 82,957 /ha). The BCR value was highest under T_6 (2.38) followed by T_7 (1.95). The highest employment generation (397 man days/year) was recorded in Rice - green gram – groundnut cropping system (T_3).
Keywords: Diversification, employment generation, Paddy equivalent yield, System productivity, System profitability.

Introduction

Rice is the second most widely consumed cereal in the world next to wheat. It is the staple food for two thirds of the world's population. Rice protein, though small in amount, is of high nutritional value. It plays vital role in the national food grain supply. India ranks second in rice production next to China (Chowdhury *et al*. 2014). Sustainability in agricultural systems is a global issue. A sustainable agricultural system must meet the changing food, fibre, fodder and fuel needs of a nation and should not be detrimental to its natural resource base. For sustainability in an agricultural system, it is desirable that a particular crop or group of crops is not grown on same soil for a long period, because various crops tap different soil layers to meet their water and nutrient requirements (Singh Ved. 2001). Diversifying rice systems in rotation with other cereals like wheat or maize, high-

*Received April 18, 2016 * Published June 2, 2016 * www.ijset.net*

value crops like vegetables, legumes, or fodder crops is one way rice farmers can optimize their use of resources. Diversified cropping systems broaden the source of a farmer's food and income, increases their land productivity, and minimizes unpredictable risks such as the build-up of pest and diseases common in rice monoculture. The increasing demand for sustainability in many has led to diversifying rice-rice or rice-wheat systems. At present, cultivars are heavy feeders and exhaustive crops, resulting in an unfavourable effect on the sustainability of soil productivity. There is a pressing need to meet the food grain requirements of the growing population and to sustain a reasonably higher productivity level. Hence, there is an urgency to diversify into new areas like vegetables, fodder, oilseeds, pulses and allied fields crops. Crop diversification has been recognized as an effective strategy for achieving the objectives of food security, nutrition security, income growth, poverty alleviation, employment generation and the judicious use of land and water resources, sustainable agriculture development and environmental improvement (Singh RD 2010). Thus, both the number and type of crops included in the cropping sequence are important. For this, heavy reliance on cereal crops needs to be shifted towards other crops such as vegetables, pulses, fodder and oilseeds. The inclusion of pulses in rice-based crop sequences in south Gujarat condition has become attractive because of the high yield and remunerative price of sorghum, groundnut and pulses. Sunnhemp enhanced performance of succeeding rice and rice fallow blackgram and soil fertility status and therefore sunnhemp-rice-rice fallow blackgram was found to be the best system for North Coastal Zone of Andhra Prades (Sai Sravan and Ramana Murthy, 2014. Gangwar and Ram (2005) reported that inclusion of legumes and other crops using intensification and interruptive approaches, as per resource availability, led to considerable improvement in productivity and profitability, on the one hand, and soil fertility, on the other hand. Hence, it was felt necessary to work out a location-specific cropping system for south Gujarat, which can utilize resources judiciously to maximize return, protect the environment and meet the day-to-day requirements of human and animals. Hence, efforts are being made to promote diversification of rice- based cropping sequence in this zone of country with fodder, legumes and oil seed crops for sustaining the productivity and meet out demand for fodder, pulses and oilseeds. Therefore, with the objective of diversification and intensification, the present investigation was carried out to find out most productive, resource-use-efficient and remunerative cropping system for this region.

Material and Methods

A field experiment was conducted in randomized block design, replicated three times at All India Coordinated Research Project (AICRP) on Farming System Research Farm, Navsari Agricultural University, Navsari, India, during 2007-08 to 2011-12, to develop a suitable cropping system by introducing pulse/oilseed/fodder into a rice-based cropping system as a second or third crop. The experimental soil was clayey in texture, alkaline in reaction (pH 7.8), 0.59 %, organic carbon, 194 kg/ha available nitrogen and 18.2 and 153 kg/ha P and K, respectively. The region predominantly humid and diurnal and seasonal variations in temperature remain in a narrow range. The 10 rice-based different cropping systems, namely *viz*. T_1: Rice -wheat –fallow; T_2: Rice - fenugreek – green gram + residue incorporation; T_3: Rice - green gram – groundnut ; T_4: Rice - Indian bean – sorghum (F) + cowpea (F); T_5: Rice – sorghum (F)- groundnut; T_6: Rice – sorghum (G)- sorghum ratoon (G); T_7: Rice – sweet corn - black gram; T_8: Rice – sorghum (G)- soybean (G) + residue incorporation; T_9: Rice – green gram - sorghum (G) + black gram (G) (1:1); T_{10}: Rice – chick pea + mustard (4:2) - sweet corn in randomized block design with three replications. Nitrogen, P and K were supplied through urea and di-ammonium phosphate, respectively as per the recommended dose of respective crops. Common application of FYM @10 t/ha was applied during *kharif* season for all the treatments. Green gram and soybean were incorporated in to soil after picking the pods at harvests. Economic yields of the component crops were converted to paddy equivalent yield (PEY), taking into account the prevailing farm gate price (Rs./kg) of crop produce. The productivity of different cropping systems was compared by calculating their economic paddy equivalent yield (PEY) using formula given by Ahlawat and Sharma (1993). System productivity was calculated as the ratio of kg PEY/ha to total crop duration of the system in days. For the available nutrient status of the soil, after completion of a crop sequence, representative soil samples were collected and analyzed for organic carbon, available nitrogen, phosphorus and potassium. The cost of cultivation, calculated on existing input cost and economic value of different crop produce, based on market price (Table 1). Gross returns were computed by considering prevailing market price of the produce. Net return was calculated by subtracting cost of cultivation from gross value of the produce, including by product value. The benefit:cost ratio (BCR) was worked out dividing net return by the cost of cultivation. The data on yield of crops and dry matter production of crops under cropping system and economics were recorded and subjected to statistical analysis as per Panse and Sukhatme (1985). The total rainfall received during the period of experimentation

was 1853 mm, 2073 mm, 1619 mm, 2185 mm and 1677mm during the year 2007-08, 2008-09, 2009-10, 2010-11 and 2011-12, respectively. No severe pests and diseases were observed during the crop growth; however, necessary plant protection measures were taken on need basis. Optimum plant population was maintained for different crops.

Results and Discussion

System productivity

System productivity (Paddy equivalent yield) was considerably higher under the rice-fodder/pulses – pulses cropping systems compared with the other systems. It was found that cropping sequences including legumes performed fairly well with regard to rice productivity. Introduction of a legume crop in rice-based cropping system may have advantages well beyond the nitrogen addition through biological nitrogen fixation including nutrient recycling from deeper soil layers, minimizing soil compaction, increase in soil organic matter, breaking of weed and pest cycles and minimizing harmful allelopathic effects (Wani *et al* ., 1995). It is evident from the data that there was significant variation among the cropping systems during all five years of the experiment and similar trends were observed with the exception of the second crop cycle (Table 1). Pooled analysis of rice yield equivalence revealed that during the five experimental years, there were significant variations among cropping systems. Maximum yield equivalence was recorded with different cropping systems showed that the during initial two years (2007-08 and 2008-09), the PEY was significantly higher under treatment T_6: Rice -sorghum (G) – ratoon sorghum (G), while in the years 2009-10 and 2010-11, it was higher under T_3: Rice (Jaya) -green gram -groundnut. In pooled results, treatment T_6: Rice -sorghum (G) –sorghum ratoon (G) recorded significantly higher paddy equivalent yield (13488 kg/ha), which was at par with treatment T_3 (13095 kg/ha), T_9 (12463 kg /ha), T_7 (12379 kg/ha) and T_2 (12273 kg/ha) (Table.1).The minimum PEY was recorded under T_1: Rice - Wheat: Fallow in all experimental years as well as in pooled (7866 kg/ha). These results corroborates the findings of Singh *et.al* (2007) who reported rice-pea-okra followed by rice-pea-onion as the most productive cropping sequence for eastern Uttar Pradesh, India. Mishra *et al* (2007) also reported higher productivity and profitability through inclusion of vegetables and pulses in rice-based cropping system.

System profitability

Among the different sequences tested, net return/ha was realized highest in the treatment T_6: Rice -sorghum (G)–ratoon sorghum (G) during all the experimental years, except 2010-11(Rs.76284, 98885, 85421 and 97859, respective years), While in case of pooled results,

highest net return/ha was recorded in treatment T_6: Rice-sorghum (G) – ratoon sorghum (G) *i.e.* Rs. 97,567 /ha followed by T_7 (Rs. 84,102 /ha) and T_2 (Rs. 82,957 /ha) (Table 2). The highest BCR value was recorded in treatment T_6: Rice-sorghum (G)– ratoon sorghum (G) during all experimental years (1.89, 2.32, 1.71, 1.90 and 1.76, respectively) followed by T_7 (1.65, 1.65, 1.49 and 1.60, respective years except 2011-12, while in pooled result it was highest underT_6(2.38) followed by T_7(1.95) (Table 2).

The mean average of five years (Table 1) indicated that, the employment generation was found highest with the crop sequence of Rice- green gram –groundnut (397 mans days/year) followed by T_5 in which paddy–sorghum (F)- groundnut crop sequence is adopted (368 mans days/year). Weeding of groundnut in heavy black soil and picking of pods for green groundnut purpose are the labour intensive operations thereby increasing the total number of man days generated in this system.

Of 10 diversified cropping systems studied for a period of five consecutive years, Crop diversification in different seasons (*kharif, rabi* and summer) enhanced the level of employment and production and regular return to farmers. On the whole, the developed cropping systems not only enhanced the level of production and employment, but also provided a regular return to the farmers throughout the year. Therefore, it was concluded that farmers with adequate resources can diversify the existing rice- wheat- fallow system with rice - sorghum- sorghum ratoon for getting higher system productivity and profitability. But, from the soil fertility improvement, productivity and profitability point of view farmer can adopt rice - sweet corn- black gram or rice - green gram- groundnut cropping system

References

[1] Ahlawat, I. P. S. and Sharma, R. P. 1993. Agronomic terminology. 3rd ed. New Delhi: Indian Society of Agronomy.

[2] Chowdhry, Md. Riton, K., Vinod, S. Abdus and Brahmachari, K. 2014 Studies on the Water Use Efficiency and Nutrient Uptake by Rice Under System of Intensification. *The Bioscan*. 9(1):85-88.

[3] Gangwar, B, and Ram, Baldev. 2005. Effect of crop diversification on productivity and profitability of rice (*Oryza sativa*)–wheat (*Triticum aestivum*) system. *Indian J Agr Sci*. 75:435–438.

[4] Mishra, M.M., Nanda, S.S., Mohanty, M, Pradhan, K.C. and Mishra, S.S. 2007. Crop diversification under rice based cropping system in western Orissa. In:Extended summaries

3rd National Symposium on IFS, October 26-28, 2007 organized by Farming System and Development Association (PDCSR, Modipuram) at ARS, Durgapura, Jaipur.

[5] Panse, U.G. and Sukhatme, P.V. 1985. Statistical methods for agricultural workers. Indian Council of Agricultural Research, New Delhi. pp. 100-174.

[6] Sai Sravan, U. and Ramana Murthy, K.V. 2014 Diversification of rice (*oryza sativa l.*) based crop-ping systems for higher productivity in northcoastal zone of andhra Pradesh. *The Bioscan* 9(4):1485-1490.

[7] Sharma, A.K., Thakur, N.P., Koushal, Sanjay, Kachroo, Dileep. 2007. Profitable and energy efficient rice-based cropping system under subtropical irrigated conditions of Jammu. In: Extended summaries 3rd National Symposium on IFS, October 26-28, 2007 organized by Farming System and Development Association (PDCSR, Modipuram) at ARS, Durgapura, Jaipur.

[8] Singh, Ved. 2001. Production sustainability and economic viability of different cropping systems under various levels of irrigation. *Indian J Agr Sci.* 71:576–580.

[9] Wani, S.P., Rupela, O.P., and Lee, K.K. 1995. Sustainable agriculture in the semi-aridtropics through biological nitrogen fixation in grain legumes. *Plant Soil:*174, 29–49.

Table 1. Paddy equivalent yield and employment generation of high intensity crop rotation under south Gujarat condition with optimum inputs

Treat.	Paddy equivalent yield (kg/ha)						Employment generation man days/year					
	2007-08	2008-09	2009-10	2010-11	2011-12	Pooled	2007-08	2008-09	2009-10	2010-11	2011-12	Pooled
T_1	8449	7610	7726	7329	8757	7866	276	273	242	232	230	251
T_2	11867	11200	13041	11884	12049	12273	378	363	332	313	301	337
T_3	12638	12483	13928	13663	13016	13095	501	451	366	353	312	397
T_4	9159	8244	10704	9330	10598	10245	354	340	323	291	269	315
T_5	11702	11335	11751	12169	14289	11937	474	422	329	330	286	368
T_6	15280	14136	13528	11050	14098	13488	357	356	375	363	257	342
T_7	15022	12051	13317	11706	11656	12379	360	324	336	324	255	320
T_8	11937	11464	10989	10608	10631	10735	387	359	355	345	275	344
T_9	13559	11782	12436	12160	12778	12463	393	371	336	332	286	344
T_{10}	13986	11110	7671	10933	11684	9168	381	363	325	232	266	313
C.D. (P=0.05)	1500	1252	1489	1170	1073	1480						
CV %	7.37	7.46	7.34	8.30	5.23	7.21						

Table 2. Economics of high intensity crop rotation under south Gujarat condition with optimum inputs available

Treat.	Gross return (₹/ha)						Net return (₹/ha)						BCR					
	2007-08	2008-09	2009-10	2010-11	2011-12	Pooled	2007-08	2008-09	2009-10	2010-11	2011-12	Pooled	2007-08	2008-09	2009-10	2010-11	2011-12	Pooled
T_1	64553	76103	77261	104287	95363	81054	27304	36992	27306	53864	43746	40664	0.73	0.95	0.55	1.10	0.85	1.01
T_2	90666	111997	130407	127117	131214	126233	47947	66715	77115	73617	74918	82957	1.12	1.47	1.45	1.40	1.33	1.92
T_3	96558	124834	139275	168198	141745	134823	41695	66679	72499	101026	67504	79840	0.76	1.15	1.09	1.50	0.91	1.45
T_4	69972	82436	107044	106944	115415	105404	26300	37017	52898	52386	52571	60264	0.60	0.82	0.98	1.00	0.84	1.34
T_5	89407	113352	117508	171338	155602	123305	36287	57044	51960	105505	84390	69677	0.68	1.01	0.79	1.60	1.19	1.30
T_6	116740	141364	135277	146225	153531	138646	76284	98885	85421	96213	97859	97567	1.89	2.32	1.71	1.90	1.76	2.38
T_7	114769	120513	133166	140910	126930	127198	71515	75097	79700	87332	71960	84102	1.65	1.65	1.49	1.60	1.31	1.95
T_8	91201	114638	109890	130289	115770	110457	47398	68644	56557	76635	54297	66098	1.08	1.49	1.06	1.40	0.88	1.49
T_9	103589	117816	124362	135522	139151	128293	58836	70825	67359	78196	77325	81661	1.31	1.51	1.18	1.40	1.25	1.75
T_{10}	106854	111100	76711	104287	127242	95002	63676	65763	21403	53864	67711	49,866	1.47	1.45	0.39	1.10	1.14	1.10
C.D. (P=0.05)							11500	12524	14887	16636	11687	15209						

Selling price (₹/kg): Rice grain 10.89, Rice straw – 1.50, Wheat – 15.0, Wheat Straw – 1.50, Fenugreek-30.0, Fenugreek stalk-2.0, Indianbean-40.0, Indian bean straw-2.0, Sorghum (F)-.1.50, Sorghum Dry fodder-2.50, Sweet corn cob-10.0, Sweet corn fodder dry – 1.50, Sorghum (G)-16.0, Green gram-50.0, Green gram Fodder -2.0, Chickpea-40.0, Chickpea straw - 2.0, Mustard-30.0, Mustard stalk -0.50, Groundnut-30.0, Groundnut haulm-3.0, Cowpea fodder-1.0, Black Gram- 30.0, Black Gram fodder-2.0, Soybean-25.0, Soybean fodder-2.0.