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Diversification of cropping system as component of small holders farming systems

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ABSTRACT

A field experiment was conducted during 2016-17 at Centre for Research on IFS, SDAU, Sardarkrushinagar, to evaluate the productivity, profitability and improving soil health with eight cropping systems with three replications under randomized block design. Results revealed that cropping system of *kharif* green gram – *rabi* fennel + cauliflower recorded significantly the highest groundnut equivalent yield (72.20 q/ha), highest net realization (₹ 2,64,719/ha), highest benefit cost ratio (2.75), highest system productivity (102.74 kg/day) and system profitability (₹ 1080/day) over rest of cropping systems.

Key words: Groundnut equivalent yield, gross return, net return, system productivity and system profitability

Diversification of cropping system is necessary to get higher yield and returns to maintain the soil health, preserve the environment and meet the daily requirement of human and animals (Samui *et al.*, 2004). Depending on just one crop can have great consequences and leave small-scale farmers open to unnecessary hazards. A slump in the market value for a particular crop could greatly reduce the income of the monoculture producers. Other factors, such as the weather or pests could destroy a large part of the crop, leaving the farmer in ruins. On the other hand, farmers with diversified production can avoid these risks, provide their families with a healthy diet and derive a whole series of other benefits.

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Choice of component crop in the cropping system representing the specific agro-ecological region needs to be suitably maneuvered to harvest the synergism among them toward efficient utilization of resource based and increase overall productivity and profitability. Crop diversification means growing a variety of crops in an area, not just one. Since last decades world is facing bad effect of climate change, in our part also farmers and scientists are facing and observing good and bad effect of climate change. Farmers are seeking alternative crops having higher price and resistance to changing environment. Marginal and small farmers are interested in integrated farming systems having resources conservation and having the efficient utilization of farm wastes and organic manures. Some cropping systems are newly emerging and it is necessary to taste their economical viability and sustainability against present cropping systems therefore present experiment is framed with different diversification cropping systems in such a manner that it can suite in integrated farming system model.

MATERIALS AND METHODS

A field experiment was conducted in randomized block design, replicated three times at Centre for Research on Integrated Farming Systems, S. D. Agricultural University, Sardarkrushinagar, Gujarat, India, during 2016-17, to develop a suitable cropping system by introducing pulse/oilseed/fodder into a groundnut-potato-pearl millet based cropping system as a second or third crop. The experimental soil was loamy sand in texture, alkaline in reaction (pH 7.6), 0.30 % organic carbon, 224 kg/ha available nitrogen and 24.18 and 242 kg/ha P_2O_5 and K_2O, respectively. The region predominantly humid and diurnal and seasonal variations in temperature remain in a narrow range. The 08 different cropping systems, namely *viz.* T_1: Groundnut-Potato-Pearlmillet; T_2: Castor-Continue-Greengram; T_3: Groundnut-Wheat + Lucerne (2:2)-Greengram; T_4: Bt Cotton + Sunhemp (1:2) –Castor-Cotton-Castor relay-Bitter gourd; T_5: Green gram-Fennel + Cauliflower (1:1)-Fennel continue; T_6: F. Sorghum-Lucerne-continue; T_7: Pearl millet-Potato-Groundnut.; T_8: Bt. Cotton (HDP)-Wheat-F. Sorghum were tried in randomized block design with three replications.

N, 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 was incorporated into soil after picking the pods at harvest. Economic yield of the component crops was converted to groundnut equivalent yield (GEY), 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 groundnut equivalent yield (GEY). System productivity was calculated as the ratio of kg GEY/ha to total crop duration of the system in days. The representative soil samples were collected and analyzed for organic carbon, available nitrogen, phosphorus and potassium after completion of crop sequence. The cost of cultivation was calculated on existing input cost and economic value of different crop produce based on market price. 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. 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. Growth and yield parameters were recorded at harvest of the crop. Seed and straw yields/ha were worked out based on yields record in each plot.

RESULTS AND DISCUSSION

An experiment was conducted during *Kharif, Rabi* and summer seasons of 2016-17 at Sardarkrushinagar to identify need based crop sequences to suit resources available and needs of arid eco-system of North Gujarat. Eight different cropping systems were tested during the study period. The crop yields obtained are converted into groundnut equivalent yield by considering the prevailing market price of different crops.

Yield and economics

The results indicated that in term of groundnut equivalent yield, crop sequence groundnut-potato-pearl millet recorded maximum

groundnut equivalent yield (83.72 q/ha) and gross realization (₹ 418590/ha) but maximum net return (₹ 264719/ha), BCR (2.75) and system profitability (₹ 1080/day) were obtained from cropping sequence of greengram-fennel + cauliflower (1:1), while system productivity (130.14 kg/ha/day) and nutrient productivity (90.57 kg/kg) were recorded higher under the treatment of crop sequence Groundnut-wheat + lucerne (2:2)-green gram. Higher values for water productivity (21.89 kg/ha-mm) were recorded under treatment which was closely followed by cropping sequence groundnut-potato-pearl millet cropping systems recorded maximum value of land use efficiency which was 97.5 % which was followed by T_7 & T_4.

Nutrient uptake

The maximum sequence total uptake of N (266 kg/ha) of sequence was noted with cropping system Bt. Cotton (HDP)-wheat-f.sorghum. Whereas, the highest P (74.68 kg/ha) uptake was recorded with cropping system groundnut-potato-pearl millet and K (205 kg/ha) was recorded with cropping system pearl millet-potato-groundnut. Cropping system greengram – fennel+ cauliflower-fennel cont. recorded the minimum total uptake of N (104 kg/ha) and K (78 kg/ha) of sequence, but sequence minimum total uptake of P (21.85 kg/ha) was recorded with cropping system castor-greengram sequence.

Soil fertility status at the end of the crop sequence

The highest content value of available N (228 kg/ha) was noted in cropping system groundnut-potato-pearl millet and available phosphorus (24.61 kg/ha) was noted in cropping system castor-green gram sequence. While available potassium (246 kg/ha) was noted the highest in cropping system pearl millet- potato-groundnut and organic carbon (3.53 g/kg) was noted the highest with lowest electrical conductivity in cropping system Bt. Cotton + sunhemp –cotton-castor relay-bitter gourd. Minimum bulk density value (1.466 g/cc) was recorded in pearl millet-potato-groundnut and maximum water holding capacity (31.0 %) was recorded in groundnut-wheat + lucerne-green gram. Status of available N, P, K, organic carbon content and water holding capacity improved over their initial status. pH maximum under groundnut-potato-pearlmillet sequence. These results are in agreement with the findings of Khosla *et al.* (2000), Rajkumara *et al.* (2014) and Singh and Ahlawat (2012).

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Table 1 Yield (kg/ha) and economics (₹/ha) of different cropping systems

Tr.	Crops in rotation			Yield (kg/ha)			Fodder/straw /stalk yield (kg/ha)			Gross return (₹/ha)	GEY* (q/ha)	Cost of culti. (₹/ha)	Net return (₹/ha)	BCR
	Kharif (K)	*Rabi (R)*	Summer (S)	*K*	*R*	S	*K*	*R*	S					
T_1	Groundnut-Potato-Pearlmillet			2125	22981	2113	3911	2293	5038	418590	83.72	161846	256744	1.59
T_2	Castor-Continue-Greengram			3264	0	727	3857	0	1713	164994	33.00	77750	87244	1.12
T_3	Groundnut-Wheat + Lucerne (2:2)-Greengram			2053	2255+37667	840	3898	4450	1927	371191	74.24	115655	255536	2.21
T_4	Bt Cotton + Sunhemp (1:2) –Castor-Cotton-Castor relay-Bitter gourd			2635+7801	2573	2619	2705	5355	3503	253492	50.70	142009	111483	0.79
T_5	Green gram-Fennel + Cauliflower (1:1)-Fennel continue			703	1617+22851	0	1798	3773	0	361010	72.20	96291	264719	2.75
T_6	F. Sorghum-Lucerne-continue			7878	656	0	2631	7709	0	108281	21.66	58109	50172	0.86
T_7	Pearl millet-Potato-Groundnut			1561	21280	2356	4848	2180	3743	403921	80.78	159646	244275	1.53
T_8	Bt. Cotton (HDP)-Wheat-F. Sorghum			2756	3933	8821	2906	4789	0	244955	48.99	134381	110574	0.82

**Groundnut equivalent yield*

Table 2 Employment generation, Nutrient productivity, land use efficiency (LUE), water productivity, system productivity and system profitability of different cropping systems

Tr.	Cropping systems			Employment generation (Man days/ha)	Nutrient productivity (kg/kg)	Land use efficiency (%)	Water productivity (kg/ha-mm)	System Productivity (kg/ha/day)	System Profitability (₹/ha/day)
	Kharif	*Rabi*	Summer						
T_1	Groundnut	Potato	Pearlmillet	262	21.70	97.53	21.89	76.46	721
T_2	Castor	Continue	Greengram	139	24.14	69.86	4.96	15.65	342
T_3	Groundnut	Wheat + Lucerne (2:2)	Greengram	247	90.57	90.14	16.42	130.14	777
T_4	Bt Cotton + Sunhemp (1:2) - Castor	Cotton-Castor relay	Bitter gourd	320	18.80	96.16	6.14	44.53	318
T_5	Green gram	Fennel + Cauliflower (1:1)	Fennel continue	199	113.33	67.12	18.55	102.74	1080
T_6	F. Sorghum	Lucerne for fodder/seed	Continue	197	21.67	57.26	2.36	40.83	240
T_7	Pearl millet	Potato	Groundnut	262	19.89	96.71	17.90	71.38	692
T_8	Bt. Cotton (HDP)	Wheat	F. Sorghum	313	17.71	70.14	6.30	60.59	432

Table 3 Average total uptake (kg/ha) of major nutrients

Trt	Treatment details			Total uptake of sequence (kg/ha)		
	Kharif	*Rabi*	*Summer*	N	P	K
T_1	Groundnut	Potato	Pearlmillet	259	74.68	184
T_2	Castor	continue	Greengram	121	21.85	82
T_3	Groundnut	Wheat + Lucerne (2:2)	Greengram	236	48.79	163
T_4	Bt Cotton + Sunhemp (1:2)	Cotton-Castor relay	Bitter gourd	203	39.11	121
T_5	Greengram	Fennel + Cauliflower (1:1)	Fennel continue	104	29.58	78
T_6	F. Sorghum	Lucerne for fodder/seed	Continue	142	30.49	120
T_7	Pearlmillet	Potato	Groundnut	259	71.4	205
T_8	Bt Cotton (HDP)	Wheat	F. Sorghum	266	47.96	183

Table 4 Soil fertility status at the end of crop sequence

Tr.	Available nutrients (kg/ha)			SOC (g/kg)	pH	EC (dS/m)	Bulk Density (g /cc)	Water Holding Capacity (%)
	N	P	K					
T_1	228	24.36	243	3.43	7.41	0.140	1.476	30.1
T_2	226	24.61	242	3.42	7.32	0.141	1.471	30.2
T_3	225	24.60	235	3.47	7.34	0.143	1.478	31.0
T_4	226	24.38	244	3.53	7.31	0.139	1.471	29.6
T_5	223	24.60	241	3.52	7.31	0.142	1.477	30.3
T_6	224	23.95	243	3.46	7.29	0.142	1.473	30.6
T_7	227	24.00	246	3.39	7.34	0.142	1.466	30.3
T_8	226	24.50	242	3.42	7.35	0.144	1.481	30.0
Initial	224	24.18	242	3.46	7.33	0.142	1.472	30.8