

Enhancing farmers' income

through crop diversification

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Crop diversification provided an opportunity to farmers for choosing more number of crops as per their available resources, facilities for cropping and their need as well as requirements of food and fodder. Inclusion of perennials in the system also provides an insurance against complete crop failure providing multiple produce in one time from same piece of land. The more number of high value crops are able to utilize the resources in better way providing higher income to the farmers.

Key words: Arid zone, Crop diversification, Farmer, High value crop, Income, Resource

CROP diversification is a tactic to maximize the use of land, water, and other natural resources for the overall agricultural development and provides the farmers with viable options to grow different crops in different agro-climatic situations. Crop diversification in India is generally viewed as a shift from traditionally grown less remunerative crops to more remunerative crops. It is necessary to arise on account of the need for (i) reducing risks associated with yield, market and prices, (ii) arresting the degradation of natural resources and the environment, and (iii) attaining national goals like employment generation, self-reliance in critical crop products and for earning foreign exchange. It can be used as an instrument to raise farm income, generate employment opportunities, conservation of natural resources and alleviate poverty.

During the last two-three decades, a shift was noticed in the consumption pattern, wherein the food consumption of cereals was declined in favour of a more varied and nutritious diet of fruits, vegetables, milk, fish, meat and poultry products. Generally crop diversification is intended to give a wider choice in the production of a

variety of crops in a given area so as to expand production related activities on various crops. Crop diversification is highlighted as it serves two purposes, i.e. increasing the income and decreasing the risk aspects of the quality and quantity of diversification. Argument is that farmers must be in a position to produce high value crops and with the increase in commercialization, should also be able to maintain the diversity in the cropping pattern to reduce the risk of production losses.

The crop diversification is also taking place due to governmental policies, thrust on some crops, market reforms, infrastructure development, government subsidies, certain other price related support mechanisms, higher profitability and stability in production also induces crop diversification. Crop diversification and growing of large number of crops are practised in dryland areas to reduce the risk factor of crop failures due to recurring droughts. Crop substitution and crop shift are also taking place in the areas suffering with some specific soil related problems.

Agricultural diversification towards horticultural and livestock products can prove to be an expedient solution, thus enhancing the employment opportunities

whereas augmenting the incomes of the farmers, scaling down the spatial and temporal irregularities, containing the better utilization of natural resources; and also increasing exports.

Major crops grown in Rajasthan

Among the production of different crops, Rajasthan produces 40% mustard, 40% pearl millet, 80% cluster bean, 95% psyllium husk, 98% henna, 65% coriander, 14% pulses, 40% cumin, 11% soybean, 8% maize, and 10% wheat. Our strength for crop diversification is growing cash crops of seed spices like cumin, coriander, fenugreek and fennel and good areas for production of quality medicinal crops like *isabgol*, *ashwagandha*, *satawari*, aloe vera, *sonamukhi* as well as the good area for the most important arid horticultural crops like *anola*, *anar*, *ber*, *lasoda* and also has a major part of production of coarse cereals (*bajra* and other small millets). The pulses like moth bean, moong bean and commercial crop like cluster bean, the unique crop grown in specially western part of the arid region of Rajasthan.

Alternative crops for diversification in arid zone: Recently the development of irrigation facilities i.e.

Table 1. Productivity and economics of different cropping systems

Systems	Pearl millet equivalent yield (kg ha ⁻¹)					Net return (₹ ha ⁻¹ y ⁻¹)	B:C ratio
	I year	II year	III year	IV year	Mean		
PM – F – PM – F	1,250	468	450	171	585	825	1.28
PM – F – CB – F	1,232	1,278	724	256	873	2,540	1.93
PM – F – GG – F	1,520	1,805	656	267	1,062	3,335	2.22
PM – M – PM – M	7,715	7,106	3,404	2,707	5,233	1,4765	2.20
PM – IG – PM – IG	3,922	2,375	2,412	1,600	2,577	7,285	2.10
PM – F – F – F	1,210	-	927	-	534	1,170	1.78
PM + S	818	734	884	939	844	1,520	1.48
S	81	1,252	1,551	1,788	1,168	3,640	2.66

PM: pearl millet, F: fallow, CB: cluster bean, GG: green gram, M: mustard, IG: *Isabgol*, S: senna

commencement of tube-wells, availability of canal water for irrigation and planting materials, many fruit trees were introduced. In western Rajasthan with highly sandy tract the introduction of olive, date palm, jojoba etc. are taken by farmers. The state agriculture department is also giving subsidy on planting material which is playing a great role in crop diversification and generating more income from same field in the region.

The few alternative crops were:

Olive: Olive plantation started in Rajasthan in 2008, is being grown on 1,000 ha, including 182 ha of seven government farms. The government farms produced 40 tonne of olive in 2015 and 250 litre of oil was extracted from this manually. The state has now set up a ₹ 4.0 million plant at Lunkaransar in Bikaner for oil extraction. Oil content in Rajasthan olives is 14%, which is very high.

Jojoba: Jojoba Plantation and Research Project in 1995 was started by Association of the Rajasthan. Farmers began planting jojoba seeds in 2007. In 2015, a man in Bikaner, who grew the exotic plant on 125 ha, exported 30 tonne of jojoba oil to Germany and United States of America. This plant can sustain in saline water and the western parts of Rajasthan and is highly suitable for its cultivation.

Date palm: Indian Council of Agriculture Research identified date palm as one of the potential crops for Rajasthan. Its cultivation introduced among farmers in Rajasthan in 2008. Date palm, an irreplaceable tree in irrigable desert lands, provides protection to under crops from heat,

wind and even cold weather and plays a big role in stopping desertification and giving life to desert areas. Farmers in Bikaner, Barmer, Jaisalmer, Churu, Sriganganagar, Hanumangarh, Jodhpur, Nagaur, Pali, Sirohi, Jalore and Jhunjhunu are growing date palm on 813 ha. The harvest was 800 tonne in 2017-18.

The cropping patterns in Rajasthan was changing markedly. The share of foodgrain in total cropped area had decreased while that of oilseed and other crops like spices, cluster bean, *isabgol* had increased. For instance, the area under cereals and pulses were 62.9 and 25.2% during 1964-65, which decreased to 35.7 and 15.2% during 2015-16. In contrast, during the same period, the area under oilseed increased from 8.9 to 18.9% between 1964-65 and 2015-16. The area under other crops mainly comprising cotton, cluster bean, seed

spices and *isabgol* increased from 1.2% to 28.4% between 1964-65 and 2015-16.

Among the cereals and millets, the area under pearl millet, sorghum, maize and barley was declined, the area under wheat was increased. The pearl millet, sorghum, maize, barley and wheat constitutes 34.5, 8.8, 5.4, 3.5 and 9.2% of cropped area during 1964-65. The respective crops had 15.9, 2.5, 3.4, 1.0 and 12.2% of cropped area during 2015-16. Among the pulse crops area under moong bean was increased, whereas the area under chickpea and moth bean declined. The area under oilseed was increased. In 2015-16, the rapeseed and mustard, soybean and groundnut constituted 10, 2.0 and 4.7% of cropped area of Rajasthan.

The area under cotton sharply increased from 1964-65 to 1992-93 and thereafter it remain almost unchanged. Seed spices, *isabgol* and cluster bean registered spectacular increase in area. Among these crops, seed spices and *isabgol* had 3.6 and 1.2% of cropped area during 2015-16, these crops were negligible areas during 1964-65. Amongst all the crops, the cluster bean registered most spectacular increase in area. In 2015-16, the cluster bean constituted 18.8% of cropped area than only 1.8% of cropped area in 1964-65.

Significances of crop diversification

Pearl millet–pearl millet is

Table 2. Economics of crop diversification in canal command area of north western Rajasthan

Crop	Area (ha)	Total irrigation water (ha cm)	Irrigation water saving (ha cm)	Pro-duction (q/ha)	Total Pro-duction (q)	Selling price (₹/q)	Total income (₹)
Kharif*							
American cotton	10	500 (5)	—	12	120	1,800	2,16,000
American cotton (50%)	5	250 (5)	250	12	60	1,800	1,08,000
Green gram (40%)	8	96 (2)	—	10	80	1,800	1,44,000
Cluster bean (40%)	4	72 (2)	—	12	48	1,000	48,000
Pigeonpea (10%)	1	30 (3)	—	12	12	1,800	21,600
Castor+	2	52 (4)	—	12	24	1,600	38,400
Moth bean (20%)	—	—	—	2	08	1,500	12,000
Rabi							
Wheat	10	500 (4)	—	30	300	700	2,10,000
Wheat (50%)	5	250 (4)	250	30	150	700	1,05,000
Mustard (35%)	3.5	105 (2)	—	16	56	1,600	89,600
Barley (20%)	2	70 (3)	—	26	52	600	31,200
Chickpea (30%)	3	75 (1)	—	10	30	1,500	45,000

*In *kharif* crops on an average 300 mm effective rainfall was considered for cotton and pigeonpea and 270 mm for other *kharif* crops. Values in parentheses indicated the number of post-sowing irrigations.

Table 3. Yield, net profit and water productivity in different cropping system at Bikaner

Treatments	Yield (kg ha ⁻¹)	Net return (₹ ha ⁻¹)	Physical water productivity (kg m ⁻³)	Economic water productivity (₹ m ⁻³)
Groundnut-wheat	3471	19,594	0.38	2.12
Groundnut-isabgol	1,851.5	17,556	0.24	2.24
Groundnut-chickpea	2,721	27,836	0.34	3.65
Cluster bean-wheat	3,171	19,640	0.46	2.75
Moong bean-wheat	3,065	41,072	0.43	5.64

traditional cropping system of the region. The continuous adoption of this system showed decline in productivity of crop. The results of a study conducted at CAZRI showed ~ 62% reduction in pearl millet yield in pearl millet - pearl millet cropping system compared to green gram - pearl millet cropping system. The substitution of pearl millet - pearl millet by pearl millet -cluster bean cropping system gave 11% higher yield of pearl millet than pearl millet - pearl millet rotation. Besides better yields, the cluster bean - pearl millet improved soil organic carbon and available P by 11.0 and 25.0%, respectively. The results of a study conducted at CAZRI, Jodhpur showed pearl millet - mustard double cropping systems gave highest net return followed by pearl millet - *isabgol*; and in mono-cropping systems sole senna is most profitable. The substitution of pearl millet - pearl millet by pearl millet - mustard and pearl millet- green gram are better cropping system under limited irrigated and rainfed conditions at Jodhpur (Table 1). A study conducted at RRS of CAZRI Bikaner showed that legume- legume (moth bean -cluster bean) cropping system had higher equivalent yields, returns and water use efficiency compared to millet- millet (pearl millet - pearl millet) systems.

Cotton-wheat is major cropping system of irrigated north-western plain zone of Rajasthan comprising canal irrigated area of Sri Gangangar and Hanumangarh districts. Both of these crops showed higher water requirement. The replacement of 50% area of cotton and wheat by other crops improved returns (Table 2).

A recent study conducted at Regional Research Station, CAZRI, Bikaner revealed that substitution of wheat by Indian mustard or *isabgol* in

cluster bean-wheat cropping systems saved 3 to 4 irrigation with better returns. The results of an another experiment conducted by RRS, CAZRI, Bikaner demonstrated that substitution of groundnut by moong bean or cluster bean in groundnut - wheat cropping system gave better returns and water productivity. The groundnut is a high water requiring crop and substitution of groundnut by low water requiring crops like moong bean or cluster bean helps to save irrigation water (Table 3).

Alternative crops

Diversification of arable cropping through inclusion of more efficient, competitive and high value - low volume commodities like medicinal, dye yielding crops is an important strategy to overcome many constraints faced by farmers in arid regions. Grain Amaranth (*Amaranthus* sp.) is a crop with multiple uses as food, fodder, medicinal and industrial oil. The feasibility of its cultivation was explored by RRS, CAZRI at Bhuj, and results indicated that cultivar GA - 2 gave return of ₹ 20,000 ha⁻¹, and hence had a commercial viability in Kachchh region. The cultivation of nutritious minor-millet (proso millet, barnyard millet, foxtail and finger millets) is also explored. Grain yield had range: 513 - 785 kg ha⁻¹. Foxtail millet had highest yield followed by proso millet and finger millet. Thus the cultivation of nutritious millets is also a viable crop diversification option for the Kachchh region.

Some of plants of medicinal utility are suitable for cultivation in arid region. *Cassia angustifolia*, *Aloe vera*, *Plantago ovata* are important medicinal plant for the arid region. In arid Gujarat, the *C. angustifolia* cultivation gave 522.6 kg ha⁻¹ dry matter with net return of ₹ 3,020

ha⁻¹ under average rainfall. Cultivation of *Aloe vera* in strip plantation with arid legumes explored at Bikaner under rainfed condition. The strip plantation of aloe with legume helps to arrest soil erosion along with yield of *Aloe vera*. *Lawsonia inermis* is a promising dye-yielding shrub. Its cultivation gave average net return of ₹ 12,500 ha⁻¹ in arid region under rainfed condition. Even during below average rainfall year (52.9 mm) it provided a net return of ₹ 6,331 ha⁻¹ at RRS CAZRI, Bhuj. The cultivation of medicinal, dye-yielding and minor millets is promising options for diversification in hot arid region.

SUMMARY

Crop substitution is major activity of crop diversification and play a great role in paradigm of sustainable agriculture. It is a shift from the traditional agriculture from less remunerative crops to high remunerative crops which is based on the demand driven, need-based and goal oriented involving spatial and temporal and value addition with resource complementary approach. The cropping intensity can be increased with the addition of more crops with less crop duration having high price value. The nature of crop diversification in today's concept is to include high value food grains from traditional low value crops. Diversification of crop sector in India plays a vital role in diversifying and commercializing agriculture. After economic reforms, change in cropping pattern from low priced food grains crops to high priced non-food grain crops was the engine of agricultural output growth. Yet, it is necessary to taking the step in the direction of reinforcement the link between production, processing, marketing and crop management. Then the shifting of cropping pattern from food grain crops to non-food crops will enable the best use of available land resources without compromising food security.

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