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RESEARCH NOTE

Changes in Cropping Pattern in Rajasthan: 1957 to 2017

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ABSTRACT

The paper examines the changes in cropping pattern in the last sixty years in Rajasthan by looking into crop area, yield, the high yielding variety of seeds and fertiliser use pattern. The time series data reveals that the cropping pattern in Rajasthan is moving in favour of wheat, oilseeds and horticultural crops. At the same time, there is a perceptible decline in the share of area under coarse cereals, sugarcane, tobacco and opium. The farmers of Rajasthan are increasingly replacing seeds in each cropping season and are also applying agro-chemicals in a greater area. Overall, higher use of purchased inputs and a shift towards more remunerative crops indicates that agriculture is getting commercialised.

Keywords: Cropping pattern, Crop, Area, Seed, Fertiliser, Rajasthan.

JEL: Q15, Q16

I

INTRODUCTION

The paper examines changes in cropping pattern in the largest state of India – Rajasthan from 1957-58 to 2016-2017. In general, the cropping pattern encompasses the study of area allocation to various crops, production and yield. To understand the cropping pattern holistically, we broaden the scope of the definition and include seed and fertiliser use pattern in it as the use of these inputs directly influences cropping pattern. Thus, the objectives of the study are to examine (1) changes in crops grown including expansion and shrinkage of area under various crops; (2) growth in horticultural crops; (3) seed replacement rate; (4) trend of chemical fertiliser use among different crops and area; and (5) yield scenario. This study does not delve into the identification of determinants of changes in cropping pattern as that has already received adequate attention.

There has been a noticeable change in area under agriculture in Rajasthan, registering a jump in net area sown and the total cropped area from 12,103 thousand hectares (hereafter, ha) and 12,944 thousand ha in 1957-58 to 18,024 thousand ha and 25,013 thousand ha in 2015-16, respectively. In other words, there has been an addition of close to 6 million ha of land to cultivation in 58 years (Government of Rajasthan, 2016, 2017). Primarily, it became possible with expansion in irrigation facility. In particular, extensive tracts of Thar desert with slant cultivation were brought under farming with 650 km long Indira Gandhi Canal (Gardiner, 1987).

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Water availability led to the settlement of people in the desert area which was earlier inhabitable.

The paper is divided into six sections. Section II describes the data and methodology. Section III lays out the major crops grown in the state of Rajasthan. A discussion on area, production and yield of horticulture crops is the focus of Section IV. Section V interprets the seed, fertiliser use practice and its inter-linkages with yield. The study ends with a conclusion in Section VI.

II

DATA SOURCE AND METHOD

The study analyses the cropping pattern at the state level using time series data. The study duration is divided into six sub-periods for which decennial averages have been worked out. Due to the limitation of data availability, different aspects are examined for different duration. For instance, crop area and yield are analysed for 30 crops for 60 years. The area, production and yield for five types of horticultural crop's are examined for seven recent years. Seed replacement rates are analysed for 18 crops with a focus on recent ten years. Fertiliser application trends are scrutinised for six crops for seven input survey rounds spread over 30 years. A comparison of fertiliser application trend in Rajasthan with that in India is assessed for eight input survey rounds covering 35 years. A limitation in using secondary data is that data concerning some crops for some years were unavailable and therefore, we had to arrive at the average with the interpolated values. The data are collected from various published sources of Commissionerate of Agriculture and Department of Planning, Government of Rajasthan, Jaipur and Ministry of Agriculture and Farmers Welfare, New Delhi. The reference period for crop data collected by the agriculture department is from July to June.

III

STRUCTURE OF CROPPING PATTERN

This section analyses the nature and structure of the cropping pattern in the state of Rajasthan starting from 1957-58 to 2016-17. The broad changes that have occurred in the area of 30 crops occupying 24,535 thousand ha (94 per cent) of the total cropped area in Rajasthan in 2016-17 are discussed. Hereafter, total cropped area implies the area under 30 crops. Some crops have been deliberately left out of the discussion, for they occupy a minor area. A large number of crops grown in two cropping season - *kharif* and *rabi* - indicates in itself that agriculture in Rajasthan is diversified. *Kharif* crops are rainfed crops, i.e. they grow with the aid of rainfall received from June to September and do not generally require water to be applied by the farmer unless rainfall delays or is inadequate. In contrast, most *rabi* season crops have to be irrigated by the farmer as there is minimal rainfall in this cropping season.

A limitation with *rabi* crops is that it is mostly taken up by those farmers who have assured irrigation facility, mostly either through canal or tubewell. Owing to limited irrigation option with farmers, large tracts of cultivable land remain fallow in *rabi* season.

The decennial average net sown area of principal crops in Rajasthan are presented in Table 1, and the decennial average percent share of principal crops to total cropped area in Rajasthan is given in Table 2. The figures in Table 2 have been derived from Table 1 only. The decennial average yield of principal crops are shown

TABLE 1. DECENNIAL AVERAGE NET SOWN AREA OF PRINCIPAL CROPS IN RAJASTHAN

(*'000 ha*)

	Season	Crops	1957-67	1967-77	1977-87	1987-97	1997-2007	2007-17
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Cereals	K	Bajra	4403.2	4655.0	4706.2	4698.5	4607.5	4662.5
	K	Jowar	1106.3	985.1	913.3	782.1	603.6	633.2
	K	Maize	666.6	769.3	889.7	921.2	1001.3	995.3
	K	Rice	95.6	130.4	161.7	133.4	134.3	149.3
	K	Small Millets	76.0	69.1	45.4	28.8	16.7	14.3
	R	Wheat	1132.5	1472.7	1876.6	1980.3	2329.6	2827.8
	R	Barley	479.2	572.4	366.3	222.3	204.2	291.1
		(A)Total Cereal	7959.4	8654.0	8959.3	8766.4	8897.1	9573.4
Pulses	K	Moth	N.A.	1612.8	1258.5	1186.6	1077.4	1179.3
	K	Green gram	N.A.	301.2	229.7	367.9	642.3	1138.8
	K	Urad	N.A.	81.5	148.3	204.2	168.5	217.2
	K	Tur (Arhar)	25.2	31.0	16.7	24.8	23.7	17.0
	R	Bengal gram	1419.3	1472.0	1658.5	1318.8	1234.2	1364.0
	R	Masoor	N.A.	11.7	18.5	15.1	25.6	40.0
	R	Pea	N.A.	10.7	9.1	7.3	12.2	8.6
		(B)Total Pulses	1444.5	3521.0	3339.3	3124.5	3184.0	3964.9
		(C) Total Foodgrain (A+B)	9403.9	12175.0	12298.6	11890.9	12081.1	13538.3
Oilseeds	K	Soyabean	0.0	0.0	24.9	258.3	595.9	946.7
	K	Sesamum	547.2	482.2	406.3	438.3	291.5	423.4
	K	Groundnut	143.5	254.7	236.1	246.0	273.5	411.9
	K	Castor	1.5	2.8	7.1	19.6	68.9	177.8
	R	Rapeseed and Mustard	255.7	271.5	640.5	2143.9	2633.0	2730.5
	R	Linseed	94.9	77.9	80.3	34.9	5.7	2.0
		(D) Total Oilseed	1042.9	1089.0	1395.1	3141.0	3868.4	4692.3
Spices	R+K	Red chilli	27.3	34.0	40.4	41.5	28.5	12.7
	R+K	Fenugreek	N.A.	28.7	32.8	30.6	44.8	82.4
	R	Coriander	N.A.	76.2	105.4	142.5	167.5	223.0
	R	Cumin	N.A.	37.8	63.4	124.1	202.3	328.8
	R	Ajwain	N.A.	9.6	13.3	15.4	13.4	17.1
		(E)Total Spices	27.3	186.3	255.3	354.1	456.5	664.0
Others	K	Guar	1140.9	1240.8	1894.5	1794.5	2216.3	3595.8
	K	Cotton	237.8	282.2	374.7	474.8	488.1	417.0
	K	Sugarcane	35.1	38.3	38.0	23.4	12.8	6.4
	R	Opium (Hectare)	5875.2	13314.8	10028.6	6453.5	7373.7	3760.7
	R	Tobacco	6.1	5.5	2.9	2.1	0.8	0.9
		(F) Total Others	7295.1	14881.6	12338.6	8748.2	10091.6	7780.9
Grand Total (C+D+E+F)			17769.2	28331.8	26287.6	24134.1	26497.7	26675.4

Source: *Agricultural Statistics* (various issues), Commissionerate of Agriculture and Department of Planning (2016), Government of Rajasthan.

TABLE 2. DECENNIAL AVERAGE SHARE OF PRINCIPAL CROPS IN RAJASTHAN

(*per cent*)

	Season	Crops	1957-67	1967-77	1977-87	1987-97	1997-2007	2007-17
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Cereals	K	Bajra	24.8	16.4	17.9	19.5	17.4	17.5
	K	Jowar	6.2	3.5	3.5	3.2	2.3	2.4
	K	Maize	3.8	2.7	3.4	3.8	3.8	3.7
	K	Rice	0.5	0.5	0.6	0.6	0.5	0.6
	K	Small Millets	0.4	0.2	0.2	0.1	0.1	0.1
	R	Wheat	6.4	5.2	7.1	8.2	8.8	10.6
	R	Barley	2.7	2.0	1.4	0.9	0.8	1.1
		(A)Total Cereal	44.8	30.5	34.1	36.3	33.6	35.9
Pulses	K	Moth	-	5.7	4.8	4.9	4.1	4.4
	K	Green gram	-	1.1	0.9	1.5	2.4	4.3
	K	Urad	-	0.3	0.6	0.8	0.6	0.8
	K	Tur (Arhar)	0.1	0.1	0.1	0.1	0.1	0.1
	R	Bengal gram	8.0	5.2	6.3	5.5	4.7	5.1
	R	Masoor	-	0.0	0.1	0.1	0.1	0.2
	R	Pea	-	0.0	0.0	0.0	0.0	0.0
		(B)Total Pulses	8.1	12.4	12.7	12.9	12.0	14.9
		(C) Total Foodgrain (A+B)	52.9	43.0	46.8	49.3	45.6	50.8
Oilseeds	K	Soyabean	-	-	0.1	1.1	2.2	3.5
	K	Sesamum	3.1	1.7	1.5	1.8	1.1	1.6
	K	Groundnut	0.8	0.9	0.9	1.0	1.0	1.5
	K	Castor	0.0	0.0	0.0	0.1	0.3	0.7
	R	Rapeseed and Mustard	1.4	1.0	2.4	8.9	9.9	10.2
	R	Linseed	0.5	0.3	0.3	0.1	0.0	0.0
		(D)Total Oilseed	5.9	3.8	5.3	13.0	14.6	17.6
Spices	R+K	Red chilli	0.2	0.1	0.2	0.2	0.1	0.0
	R+K	Fenugreek	-	0.1	0.1	0.1	0.2	0.3
	R	Coriander	-	0.3	0.4	0.6	0.6	0.8
	R	Cumin	-	0.1	0.2	0.5	0.8	1.2
	R	Ajwain	-	0.0	0.1	0.1	0.1	0.1
		(E)Total Spices	0.2	0.7	1.0	1.5	1.7	2.5
Others	K	Guar	6.4	4.4	7.2	7.4	8.4	13.5
	K	Cotton	1.3	1.0	1.4	2.0	1.8	1.6
	K	Sugarcane	0.2	0.1	0.1	0.1	0.0	0.0
	R	Opium (Hectare)	33.1	47.0	38.1	26.7	27.8	14.1
	R	Tobacco	0.0	0.0	0.0	0.0	0.0	0.0
		(F) Total Others	41.1	52.5	46.9	36.2	38.1	29.2
Grand Total (C+D+E+F)			100.0	100.0	100.0	100.0	100.0	100.0

Source: Author's estimate using Table 1.

in Table 3. Using the time series data, we have constructed decennial average to analyse data of six decades – 1957-67, 1967-77, 1977-87, 1997-2007 and 2007-17. The first decade after Independence has been left out due to non-availability of data. The crops grown are categorised under five heads: (1) cereals: bajra (pearl millet), jowar, maize, rice, small millets, wheat, barley; (2) pulses: moth, moong (green gram), urad, tur (arhar), chana (bengalgram), masoor, pea; (3) oilseeds: soyabean, til (sesamum), groundnut, castor, rapeseed and mustard, alsee (linseed); (4) spices: red chilli, methi (fenugreek), dhania (coriander), jeera (cumin), ajwain; (5) others: guar (cluster bean), cotton, sugarcane, afeem (opium), tobacco. The detailed analysis of these crops is as follows:

TABLE 3. DECENNIAL AVERAGE YIELD OF PRINCIPAL CROPS IN RAJASTHAN

(*kg/ha*)

	Season	Crops	1957-67	1967-77	1977-87	1987-97	1997-2007	2007-17
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Cereals	K	Bajra	223.1	269.3	242.0	381.7	571.1	847.3
	K	Jowar	310.4	343.4	381.4	379.1	384.0	613.8
	K	Maize	943.5	878.8	868.0	1006.4	1203.0	1603.0
	K	Rice	757.6	966.1	995.1	965.7	1186.9	1967.9
	K	Small millets	372.5	295.0	203.1	222.6	348.8	387.9
	R	Wheat	874.8	1182.4	1640.7	2275.4	2657.8	3129.3
	R	Barley	1113.6	1195.4	1400.3	1734.0	2224.0	2795.6
Pulses	K	Moth	-	174.8	124.5	197.7	179.9	299.9
	K	Green gram	-	244.1	158.4	267.4	240.6	411.1
	K	Urad	-	388.0	326.7	330.4	332.7	485.7
	K	Tur (arhar)	353.3	417.6	337.6	500.2	662.2	735.5
	R	Bengal gram	516.3	652.0	700.6	665.1	709.3	793.3
	R	Masoor	-	696.0	705.6	825.8	1048.2	910.2
	R	Pea	-	585.0	1076.0	2047.2	2133.2	1879.2
Oilseeds	K	Soyabean	-	-	681.0	989.8	1126.3	1151.0
	K	Sesamum	113.7	114.7	106.1	188.7	212.8	308.5
	K	Groundnut	510.8	557.1	611.5	874.3	1199.3	1798.1
	K	Castor	359.9	303.6	241.5	866.0	1078.7	1353.4
	R	Rapeseed and Mustard	510.8	557.1	611.5	874.3	1199.3	1798.1
	R	Linseed	214.5	295.8	352.3	411.6	725.4	1232.1
Spices	R+K	Red chilli	551.8	537.9	571.7	1075.5	1180.8	1378.0
	R+K	Fenugreek	-	N.A.	1067.0	1046.8	1155.8	1131.6
	R	Coriander	-	554.0	544.5	790.0	1085.2	1062.9
	R	Cumin	-	N.A.	N.A.	331.7	382.1	386.1
	R	Ajwain	-	N.A.	N.A.	N.A.	489.8	662.9
Others	K	Guar	228.9	251.6	192.7	250.6	234.7	446.8
	K	Cotton	128.9	172.7	230.0	315.4	254.7	485.4
	K	Sugarcane	9939.2	33346.2	40387.6	46032.9	49041.8	64750.6
	R	Opium (hectare)	32.7	28.3	39.3	43.0	54.5	62.8
	R	Tobacco	646.8	689.6	926.2	1401.3	1594.8	1405.1

Source: *Agricultural Statistics* (various issues), Commissionerate of Agriculture and Department of Planning (2016), Government of Rajasthan.

(1) *Cereals*

Among cereals, across six decades, bajra is the most cultivated crop occupying the highest area in the range of 14-19.5 per cent of the total cropped area. Interestingly, Rajasthan also happens to be the largest bajra growing state in the country. The geo-physiological and climatic conditions of Rajasthan support the cultivation of coarse cereals, particularly bajra, and jowar, maize, small millets, among others. Bajra, a rain-fed crop, commands the highest area among the foodgrain crop as it can be grown with very less water. Even 3-4 rainfall showers are sufficient for bajra crop. That is why it is grown by most farmers of Rajasthan irrespective of land size and availability of irrigation facility. Although monetarily it is a low priced grain with poor yields in comparison to wheat or rice, nutritionally it is high and is consumed by people during the winter season in the State. The area under bajra crop has remained unchanged in six decades, hovering between 4403 to 4706 thousand ha,

but the production has surged with a four-fold increase in yield from 223 kg/ha in 1957-67 to 847 kg/ha in 2007-17 (Table 3).

Among other rainfed coarse cereals, jowar was ahead of maize for the first three decades, from 1957 to 1987, while in the later three decades from 1987 to 2017, maize took over jowar. It has been so due to a change in food habits leading to a decrease in demand for jowar as a foodgrain, while an increase in demand for maize from the poultry sector for feed.

Small millets command low consumer preference. Therefore with each passing decade, there has been a constant decline in area under small millets, from 76 thousand ha (0.4 per cent) in 1957-67 to 45 thousand ha (0.1 per cent) in 1977-87 and further to 14 thousand ha in 2007-17. The reason behind the decline in the area of small millets can be attributed to the change in food habits towards rice and wheat which were only supplied under the public distribution system (PDS). As a result of less demand and being a less valued crop, farmers have also shrunk the area cropped under small millets. Moreover, due to non-availability of high yielding seeds of small millets, there is a minimal increase in yield, which even went down from 372 kg/ha in 1957-67 to 203 kg/ha in 1977-87 and then rose back to only 387 kg/ha in 2007-17 (Table 3).

Rice, a water-intensive crop, is mostly grown in canal command area and area with high rainfall. The erratic rainfall and limited command area make rice cultivation a risky exercise for the farmers of Rajasthan. Therefore, the area under rice has remained in the range of 96-162 thousand ha (Table 1) over the years of study. Despite rice being relatively more remunerative and having achieved more than 2.6 times increase in yield in six decades, it has not been able to cross even 1 per cent of the cropped area of the dry state (Table 2).

Wheat and barley are two similar kinds of cereals grown in the *rab*i season in Rajasthan. With expansion in public and private irrigation facilities, the area under wheat has more than doubled in 60 years, covering 2,827 thousand ha area in 2007-17, which is around 10 per cent of the cropped area in the same duration. One of the most important reasons behind wheat being a favourite crop of farmers is easy availability of high yielding seeds which increased yield by 3.6 times, from meagre 874 kg/ha to 3,129 kg/ha in six decades. However, Rajasthan remains behind Punjab where the average wheat yield in 2014-15 was 4,294 kg/ha (Mann, 2017), while in Rajasthan state it was 2,961 kg/ha and even the highest yield in Jhunjhunu district - 4032 kg/ha was behind Punjab (Government of Rajasthan, 2017). The same inclination is not found for barley crop, for it has lost preference among consumers, bringing the area down to half in 2007-2017 relative to 479 thousand ha in 1957-67. Anyhow, a part of the demand of barley from the liquor manufacturing industry has kept farmers motivated in cultivating it in 291 thousand ha (1.1 per cent) in the latest decade of 2007-2017. Also, the yield in barley, which albeit increased 2.5 times, it stood at 2,795 kg/ha in 2007-17, which was less than wheat by 333 kg/ha. Overall,

the per cent share of cereals is following a downward trend from 44 per cent to 35 per cent in 2007-17 over 1957-67.

2) *Pulses*

The analysis of pulses and spices is limited by the unavailability of information for the first decade under study, i.e. from 1957-67. For the nextforty years, i.e. from 1967 to 2007, the total area under seven different pulses has almost remained unchanged, in both percentage (12 per cent) and absolute number (3,100 thousand ha). It is in the recent decade of 2007-17 that the area under pulses expanded from 12 to 15 per cent. It may have become possible owing to the great impetus given to the pulses promotion programme by the Ministry of Agriculture.

Moth, urad, tur and green gram are the rainfed pulses, while bengal gram, masoor and pea are *rabi* season pulses grown in Rajasthan. Together, foodgrain crops (both cereals and pulses) occupy over half of the cropped area. If we observe the same in absolute number, above 4000 thousand ha area has additionally come under foodgrain crop cultivation in 2007-17 over 1957-67.

3) *Oilseeds*

In the non-foodgrain crop category, oilseed crops from which oil is extractedare discussed. Oil is an essential ingredient in the food of Rajasthani people. It is important to note that oilseed crops are cultivated majorly for commercial sale because the direct consumption of oilseed such as soyabean, sesamum and groundnut, is quite less and therefore a large part of the yield is sold. Extracting oil at home is not possible. Therefore, even the farm families consuming soyabean, sesamum or groundnut oil have to sell the yield in the market and later purchase fully processed oil, as and when required.

Within six different oilseeds, it is to be noted that soyabeanwas not traditionally grown in Rajasthan. Its cultivation started in 1980-81 when 4.80 thousand ha area was brought under it. Ever since then, with each passing year, barring few exceptions, there has been a surge in area cultivated under soyabean. In 1987, the area under soyabean which was 24 thousand ha registered more than tenfold jump and reached 258 thousand ha area in 10 years. Another ten years saw doubling of the area under soyabean when it covered 595 thousand ha in 1997-2007. The expansion journey continued, andsoyabean got spread to more than 946 thousand ha in 2007-17. The wide acceptance of soyabean by farmers is credited for it being a cash-rich crop, rightly known as “Golden Bean”. Also, soyabean is preferred by farmers over other cash crops for its short cultivation cycle of around three months that has become possible with the high yielding seeds. Being a legume crop, it leaves the soil nitrogen-rich, benefitting the growth of the crop grown in the following season. It requires less water, is tolerant to yellow mosaic disease and the yield is ever

increasing from 681 kg/ha in 1977-87 to 989 kg/ha in the next decade and reached to 1,151 kg/ha in 2007-17.

Contrary to soyabean, sesamum covered the most extensive area at the beginning of the study period. Subsequently, sesamum area coverage started declining and reached a minimum of 291 thousand ha in 1997-07. In the next decade, sesamum witnessed an improvement in the area and touched the mark of 423 thousand ha in 2007-17.

A noteworthy aspect about groundnut crop is that with each passing decade, especially from 1967-77, the average crop yield has increased by multiple proportions, crossing a mark of 300 per cent increase in 2007-17 over 1967-77. However, despite an appreciable improvement in yield, the average per cent share of the crop hovered between 0.8 to 1 per cent for the first five decades. It is in the recent decade of 2007-17 that the average net sown area of groundnut increased to 411 thousand ha over 273 thousand ha in the previous decade.

Unlike groundnut, castor crop has witnessed a parallel increase in both net sown area and average yield during the study period. Albeit its net sown area which was only 1.5 thousand ha in the first decade reached 177 thousand ha in 2007-17, castor remains behind the above mentioned oilseed crops of *kharif* season.

Rajasthan is the fore runner in mustard production in India, occupying above 10 per cent of the sown area in 2007-2017. Mustard constantly competes for an area with other *rabi* crops like wheat. Another *rabi* season oilseed crop is linseed which has witnessed a downward trajectory, remaining limited to only 2 thousand ha area in 2007-2017 against 94 thousand ha in 1957-67. As linseed requires irrigation, farmers choose to grow other irrigated crops grown at the same time, such as wheat, mustard and spices, which command greater demand in the market.

Overall, a common feature across groundnut, soyabean, castor and mustard is that these oilseed cropshave seen enormous expansion in area in each decade, starting from 1957-67 to 2007-2017. There has been a three-fold increase in the yield of these oilseed crops (Table 3). It indicates greater commercial orientation among farmers who are adding more area under cash-rich crops to enhance their earning. On the other hand, linseed consumption as raw seed and as oil is quite less in comparison to other oils within Rajasthan and elsewhere. Thus, the change in cropping pattern reflects that farmers consciously choose to cultivate crops with high demand as they offer a higher scope of profit making.

4) *Spices*

In spices category, Rajasthan is at the forefront in the production of fenugreek, coriander and cumin in India. Spices are also cash- rich commercial crops as they are grown for sale in the market to generate cash, besides keeping a small portion for household consumption. An important aspect which indicates that farmers are moving towards commercial farming can be ascertained from the fact that area of all

spices - fenugreek, coriander, cumin, ajwain, barring red chilli has increased in the period under study (Table 1). Although the overall area occupied by spices is marginal, the total area under these five dominant spices has leapt from a mere 0.2 to 2.5 per cent in six decades (Table 2).

5) *Others*

In the last category of 'Others', five different type of cash crops have been included. Of the kharif crops, sugarcane being a water-intensive crop occupies a minor area in the water-starved state of Rajasthan and so has been reduced to less than one-fourth (6 thousand ha) of what it was at the beginning of the reference period (35 thousand ha). Cotton, grown for fibre, has indeed doubled in the state from 237 to 417 and undergone close to four-fold increase in yield from 128 kg/ha to 485 kg/ha during 1957-67 to 2007-17. However, being water thirsty, this 'white gold' crop has occupied just 1-2 per cent of the cropped area in the total study duration.

Against it, Rajasthan farmers prefer to grow very less water requiring crop like guar whose area has increased by leaps and bound. Guar, a traditional crop consumed by local people as vegetable and as fodder witnessed a rise in demand when the processed guar gum (powder) from guar crop received wide industrial usage in food, cosmetic, printing, pharma and textile. Further, high demand from shale oil gas fracking industry in America led to a drastic increase in prices during 2011 and 2012 (NIAM, 2013; 2014; NRAA, 2014). This has motivated farmers to cultivate a minor crop on an extensive scale, taking the guar area to a new peak of 4000-5000 thousand ha for four years, from 2012-13 to 2015-16. Interestingly, the yield has also doubled from 228 kg/ha to 446 kg/ha in sixty years.

Tobacco, a non-food crop has experienced a seven-fold decline in the area from more than 6 thousand ha to less than a thousand ha in six decades. The decline in area under tobacco is part of the agenda of the macro political-economy. India is a signatory to the WHO's Framework Convention on Tobacco control which makes it obligatory to take steps to reduce tobacco consumption. In this light, the government has addressed the problem by hitting at its root cause, i.e., production. Under a government programme, tobacco cultivating farmers are encouraged to move to alternative remunerative crops. The results of the government programme have started reflecting with a decline in the tobacco area in Rajasthan as well as in several other states.

Opium, a notorious cash-rich crop, as its other name 'black gold' indicates, has rececedin-terms of area occupancy from 5875 thousand ha (33 per cent) in 1957-67 to 3760 thousand ha (14 per cent) in 2007-17. The Government of India allocates license and land area to farmers in Rajasthan, along with those in Uttar Pradesh and Madhya Pradesh, for legally growing opium crop which has high demand in the pharmaceutical industry for developing pain-relieving medicines. Farmers also take an interest in its cultivation for illegal sale to drug peddlers. Despite high demand and

a doubling in yield from 32 kg/ha to 62 kg/ha at (at 70ºC) in six decades, opium cultivation has decelerated. The stringent law regarding yield and sale, tedious cultivation of opium crop and fragile natureof the crop has pushed farmers towards hassle free and more remunerative orange crop. Although farming continues on commercial lines, farmers have drifted away from illegal to the legal route of cash generation by moving from a drug crop to a citrus crop.

IV

HORTICULTURE CROPS: AREA, PRODUCTION AND YIELD

Horticulture crops grown in the state of Rajasthan are analysed here from 2010-11 to 2016-17, the duration for which data were available. Although horticulture crops are not new to Rajasthan, the thrust on these crops has indeed increased phenomenally in recent seven years, as evident from the area, production and yield data presented in Table 4. The wide range of horticultural crops covered in the data are: fruits (mango, guava, lemon, orange, kinnow, mosambi, malta, pomegranate, ber, aonla, papaya, blackberry, grapes, chiku, banana, phalsa, mulberry, custard apple, others); vegetables (onion, tomato, potato, brinjal, okra, tinda, cucumber, long melon, pumpkin, bottle guard, ridge guard, bitter guard, cabbage, cauliflower, carrot, radish, peas, guar, sweet potato, spinach, colocassia, watermelon, muskmelon, others); spices (ginger, turmeric, garlic, fennel, chilli, coriander, cumin, fenugreek, ajwain); medicinal and aromatic crops (ashwagandha, chakori, isabgoal, kalonji, mehandi,

TABLE 4. AREA, PRODUCTION AND YIELD OF HORTICULTURE CROPS

(*Area in ha, production in m.t., yield in kg/ha*)

Crops (1)		2010-11 (2)	2011-12 (3)	2012-13 (4)	2013-14 (5)	2014-15 (6)	2015-16 (7)	2016-17 (8)
Fruit	A	33534	34422	36418	39113	39438	40569	53092
	P	457417	382194	559497	655235	735601	651358	961597
	Y	13640	11103	15363	16752	18652	16056	18112
Vegetable	A	154392	172394	133264	149642	153916	194645	170132
	P	948303	1227272	878911	1107611	1433228	2020957	1812848
	Y	6142	7119	6595	7402	9312	10383	10656
Spices	A	698561	975189	803266	808863	851465	1001737	991588
	P	668979	954392	705304	668734	608828	1050169	1549804
	Y	958	979	878	827	715	1048	1563
Medicinal and aromatic	A	286251	280638	237823	231242	400110	369613	411844
	P	146712	149608	125909	124304	151826	186783	356081
	Y	513	533	529	538	379	505	865
Flowers	A	3143	2485	2889	2533	2993	3331	2716
	P	5241	2692	3081	2729	4159	5852	3734
	Y	1668	1083	1066	1077	1390	1757	1375
TOTAL	A	1175881	1465128	1213660	1231393	1447922	1609895	1629372
	P	2226652	2716158	2272702	2558613	2933642	3915119	4684063
	Y	1894	1854	1873	2078	2026	2432	2875

Source: Directorate of Horticulture, Department of Agriculture, Government of Rajasthan, Jaipur www.agriculture.rajasthan.gov.in.

A=Area, P=Production, Y=Yield.

sonamukhi, dil seed, tulsi, safedmusli, aloe vera, opium, others); and flowers (rose, kusum, marigold, phulwari, jafari/javara, others). Some of the spices, guar and opium have already been referred in the previous section. Horticulture also includes plantation crops, but these are not grown in Rajasthan.

The trend in horticultural crop growth reflects an increase in area, production and yield of horticulture crops from 2010-11 to 2016-17, especially vegetables and fruits. To be specific, the area under horticulture crops stood at 1.17 million ha in 2010-11 and expanded to 1.62 million ha in 2016-17, implying an addition of 0.45 million ha under high value and remunerative crops. That is why horticulture crop cultivation has been termed as "Golden Revolution". Both, the large area covered by horticulture crops and expansion in that area are a clear indication that commercialisation of agriculture is gaining momentum in the state. Rajasthan appears to be making a significant contribution in taking India ahead in the production of horticulture crops with a marked acceleration in output and productivity. In just seven years, the production has more than doubled from 2226 thousand metric ton (MT) in 2010-11 to 4684 thousand MT in 2016-17 and yield has witnessed 151 per cent leap from 1894 kg/ha to 2875 kg/ha during the same duration. It is the technologically modified high yielding seeds of horticulture crops that have brought about the exponential growth. The wave of agrarian transition has pushed the farmers to shift from essential subsistence oriented foodgrain crop cultivation to non-edible cash cropping, such as flowers, medicinal and aromatic plants, for meeting the high-end urban demand and also for raising one's farm income. To put differently, the shift from food to non-food crops is on account of a higher profit margin.

V

SEED, FERTILISER AND YIELD: THE INTER-LINKAGES

After obtaining an overview of the crops which occupy the dominant area in the landscape of Rajasthan, we move on to the second part of the study which analyses the inter-linkages between input and output. In input, we examine the high yielding seeds, andfertiliser use practices for these two are the critical requirements for the cultivation of a crop. Furthermore, their use also influences a farmer's decision about area allocation to a crop.

(1) *Trend of High Yielding Seeds Use*

Seed is a fundamental input for the cultivation of a crop. The technologically innovated high yielding variety (HYV) of seeds have changed the way seeds were preserved and passed on from generation after generation. Today, it is the high yielding seeds which dominate across crops as evident in the literature (Sagar, 1978; Matuschke and Qaim, 2008; Matuschke, *et al.*, 2007). We assess the seed usage practice by looking at the crop-wise trend of seed replacement rate in Rajasthan in the

recent decade of 2007-17. Seed replacement rate (per cent) (SRR) or seed replacement ratio is a measure of how much of the total cropped area under a specific crop was sown with certified seeds in comparison to farm-saved seeds. Before the advent of high yielding seeds variety in 1965 in Indian fields, it is the farm-saved seeds which were used to grow the crop year after year. This practice has been broken down with the high yielding seed culture. Now there is a greater thrust on purchasing new seeds from the market in each cropping season. The argument is backed by data from 18 different crops whose seed replacement rate has increased in 2016-17 over 2007-08, as shown in Table 5. The fact that the seed replacement rate is increasing implies that farmers are using more of high yielding seeds which need to be changed almost in each cropping season to obtain a higher and uniform yield. Moreover, had a significant percentage of farmers been using traditional open-pollinated/heirloom/ landrace seeds, then the seed replacement rate would not have shown an increasing trend.

TABLE 5. TREND CROP WISE SEED REPLACEMENT RATE IN RAJASTHAN

(*per cent*)

Crop	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Mustard	81.5	77.91	99.17	86.65	93.04	83.69	81.02	90.32	74.81	78.53
Bajra	34.59	46.2	46.25	45.64	57.28	64.5	59.83	57.92	58.88	65.39
Castor	32.36	38.15	37.24	27.31	28.98	40.71	50.84	46.41	31.89	49.68
Sesamum	26.35	22.54	24.55	22.38	20.07	21.41	20.23	30.27	31.04	55.55
Maize	24.07	42.13	41.02	40.84	52.66	44	54.93	51.35	42.31	42.29
Barley	20.38	26.67	37.14	25.23	34.87	34.6	37.25	38.73	43.96	40.36
Wheat	25.98	31.77	42.61	25.5	30.45	32.32	31.93	32.63	32.51	31.18
Arhar	19.94	25.95	19.88	26.69	21.7	33.18	15.25	23.43	5.83	20.79
Jowar	7.26	9.01	8.7	15.46	21.89	26.1	21.95	16.45	27.92	28.26
Green gram	14.49	23.07	22.58	21.25	18.35	24.79	23.79	22.05	20.35	14.56
Soyabean	11.67	18.19	21.21	28.36	28.33	25.38	23.49	28.65	18.51	14
Urad	12.91	12.59	14.65	14	6.94	10.33	11.9	10.87	12.96	18.19
Bengal gram	5.25	5.09	7.39	8.52	12.54	13.75	11.79	18.24	17.84	14.95
Paddy	5.3	13	6	5.08	7.34	11.27	10.07	10.25	8.81	14.04
Guar	5.43	10.51	10.02	9.32	9.17	6.93	7.43	6.46	13.68	11.07
Groundnut	2.84	4.59	9.42	7.13	6.05	5.98	4.05	8.7	7.56	7.28
Cotton	66.79	64.06	34.5	65.55	30.9	19.35	23.37	18.7	24.7	6.49
Moth	2.77	4.65	6.93	4.79	5.73	14.07	9.43	7.95	6.55	5.69

Source: *Rajasthan Agricultural Statistics at a Glance*, various issues from 2007-08 to 2016-17, Commissionerate of Agriculture, Rajasthan, Jaipur.

Crops such as Bt cotton seed replacement rate is 100 per cent, while that of other varieties of cotton shown in Table 4, namely, deshi cotton, Rajasthan American cotton, DCH cotton, Shanker 4 cotton, Shanker 6 cotton, Malvi/Punjab American cotton has followed a downward trend. Precisely, cotton is a unique case in which farmers are sowing Bt variety with newly purchased seed in each season while of other varieties, the replacement rate in 2016-17 was only 6 per cent. Besides cotton, mustard - a cash crop has witnessed highest seed replacement rate in all the ten years, oscillating between 74-99 per cent. It also happens to be so high because, in several places in Rajasthan, *margoja* (orobanche) weed in mustard crop has been reported by

farmers, which reduces the yield. Re-using the infected crop seed in the next sowing cycle is not advisable as it would reduce the yield further. Therefore, farmers prefer to invest in the purchase of a new seed packet to get high yield and consequently higher income.

Besides mustard, other oilseeds that are grown for commercial sale purposes, such as castor and sesamum had a high seed replacement rate of 55 per cent and 50 per cent, respectively in 2016-17. Among foodgrain crops, bajra, a principal cereal crop, had the highest seed replacement rate hovering around 65 per cent in 2016-17.

Of all the crops listed in Table 5, moth had the least seed replacement rate of around 5 per cent in 2016-17. From 2 per cent in 2007-08, it reached a peak of 14 per cent in 2012-13 and then again followed a declining trend. For growing moth, which is a rainfed crop, use of traditional seeds are more common against high yielding seeds as they require more water which a farmer having unirrigated land cannot fulfil.

(2) *Chemical Fertiliser Use Trend*

Chemical fertiliser, synthetic fertiliser, inorganic fertiliser or agro-chemical, all point towards human-made nutrient which are applied to the soil for enhancing its physical properties which in turn boost plant growth. Nitrogen (N), phosphorus (P), and potassium (K) are the three primary plant nutrients. The study analyses the trend of one or more chemical fertiliser use.

To understand fertiliser use practice, we analysethe percentage of the area treated with one or more chemical fertiliser to the total area in Rajasthan under six crops in combine irrigated and unirrigated area for 30 years, as shown in Table 6. The data have been obtained from seven input survey rounds, each conducted at a gap of four years, starting from 1981-82 to 2011-12 by the Ministry of Agriculture. We have taken three crops from each season, i.e., three irrigated crops and three rain-fed crops. In irrigated crop, namely wheat and mustard, the fertiliser use is undoubtedly more than rain-fed crops. However, cotton, a rain-fed crop, is an exception to the rule. In wheat, mustard and cotton, close to 90 per cent of the crop area were fertilised in the recent input survey year of 2011-12. Each of these crops, mustard – an oilseed crop,

TABLE 6. PERCENTAGE OF AREA TREATED WITH FERTILISER TO TOTAL AREA UNDER SELECTED CROPS IN COMBINE IRRIGATED AND UNIRRIGATED AREA IN RAJASTHAN

(*per cent*)

Crop	1981-82	1986-87	1991-92	1996-97	2001-02	2006-07	2011-12
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Wheat	59.7	89.5	73.2	91.3	88.5	93.0	93.0
Mustard	31.6	76.2	79.2	86.3	84.3	91.8	86.9
Bengal gram	1.9	21.1	16.1	N.A.	29.4	27.0	39.3
Cotton	78.2	N.A.	93.9	N.A.	96.2	95.7	91.0
Bajra	4.3	7.0	10.6	15.0	20.0	24.9	40.1
Jowar	3.0	16.1	17.3	N.A.	13.5	N.A.	39.7

Source: Input Survey of various years, Ministry of Agriculture and Farmers Welfare, New Delhi.http://agcensus.nic.in/.

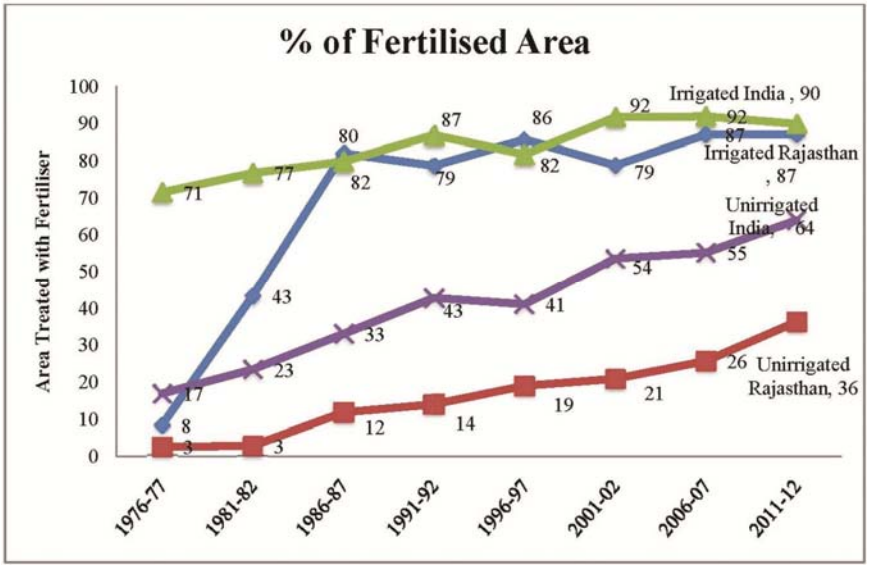
NA= Not available.

wheat – a principal foodgrain crop and cotton – a fibre crop, are quite different from each other, yet one aspect which runs common among them is the high commercial demand of the crops due to which farmers unhesitatingly invest in fertiliser in a greater area. It is so because the scope of profit generation expands with higher demand and supply which makes fertiliser cost recovery possible.

Bengal gram, being a leguminous crop, requires very less fertiliser. Rather the soil where bengal gram is grown becomes nitrogen-rich and the crop grown in the following season mostly rotated with cereals, such as bajra and jowar, require less fertiliser. Also, it is to be noted that bajra and jowar are rain-fed crops, in which due to the uncertainty of rain, fewer farmers, mostly those with assured irrigation at their disposal, take the risk of applying fertiliser. Further, being coarse grains, as bajra and jowar have low market value, not many farmers show an inclination to increase the cost of cultivation by applying fertiliser. Moreover, as mentioned, bengal gram grown before cereals leaves soil nitrogen-rich which reduces the need to replenish the soil by applying additional chemical fertiliser. Therefore, in bengal gram, bajra and jowar, area close to only 40 per cent were fertilised in 2011-12.

Overall, in all edible and non-edible crops, be it principal foodgrain (wheat), coarse foodgrain (bajra, jowar), oilseed (mustard), pulse (bengal gram), or fibre crop (cotton), there has been a substantial increase in area over which one or the other chemical fertiliser was applied in 2011-12 over 1981-82.

After crop-wise analysis of fertiliser application, irrigated and unirrigated area-wise evaluation of fertiliser application trend for all the crops in Rajasthan is done for 35 years, and the same is compared with all-India level. Figure 1 shows per cent of



Source: 'All India Report on Input Survey' of various years, Ministry of Agriculture and Farmers Welfare, New Delhi.http://agcensus.nic.in/

Figure 1. Per cent of Fertilised Area.

the fertilised area in irrigated Rajasthan and India and likewise in unirrigated Rajasthan and India, starting from 1976-77, i.e. a decade after the introduction of the high yielding variety of seeds and fertiliser package in India until 2011-12. Certainly, fertiliser was applied to a higher per cent of crop area under irrigated conditions in both Rajasthan and India compared with unirrigated Rajasthan and India. It has been so because there is a deep association between fertiliser and water. The soil where chemical fertiliser is applied compulsorily requires water so that soil can absorb the fertiliser and it reaches up to the roots which in turn induces plant growth. Fertiliser application without simultaneous application of water can prove fatal for the growth of the crop. Water is a binding constraint in the use of high yielding seeds and fertiliser. As the water availability increases, the area under high yielding seed and fertiliser expands.

In a decade, the seed-fertiliser package introduced in Punjab-Haryana in 1965-66 had diffused to a limited area in Rajasthan, unlike other areas. It is due to this that in 1976-77, fertiliser was applied in only 8 per cent of irrigated crop area in Rajasthan, while for irrigated India as a whole, the figure was as high as 71 per cent. The expansion of irrigated area in Rajasthan led to an increase in fertiliser use. Within four to eight years, Rajasthan experienced exponential growth in fertiliser application, and the percent of the area treated with one or more chemical fertiliser to the total area under selected crops touched the mark of 82 per cent in 1986-87, surpassing the fertilised area of 80 per cent in India during the same time. Since then, there has been a narrow gap in the area treated with fertiliser between Rajasthan and India as a whole, except for the year 2001-02, when owing to rainfall shortage, an area in Rajasthan was fertilised less by 13 per cent than that in India. So for over two and half decades, from 1986-87 to 2011-12, cropped area treated with chemical fertiliser in both Rajasthan and India hovered in the range of 79 to 92 per cent. A high percentage of all crop area treated with fertiliser reflects that farmers are using fertiliser on an extensive scale.

In the unirrigated belt of Rajasthan as well as India, fertiliser application has increased during eight input survey rounds. To obtain the benefit of fertiliser, many farmers apply it right before or at the time of rainfall. At the beginning of the study period, i.e. in 1976-77, fertiliser application was limited to hardly 3 per cent the total area under selected crops in the unirrigated Rajasthan, against 17 per cent area in India. In 35 years, the area treated with fertiliser to the total area under the selected crops took a 12 fold leap in Rajasthan and reached 36 per cent. However, in 2011-12, close to double of this area was treated with fertiliser in unirrigated India.

In a nutshell, data from input survey reflects that year after year fertiliser application is growing in both irrigated and unirrigated land of Rajasthan state and the country as a whole. Increasing fertiliser use is a clear sign of penetration of capitalist forces which has accelerated commercialisation of agriculture. The ubiquitous use of modern technological input in the form of high yielding seeds and chemical fertiliser raises a question that how and in what proportion they have

influenced the output. To trace the linkage, we will next examine the yield of principal crops in Rajasthan which were touched prior in the discussion under section III.

3) *Yield*

There is a strong relationship between high yielding seeds, fertiliser and yield. Table 3 demonstrates the average yield statistics of 30 principal crops for over six decades, starting from 1957-67 to 2007-17, the same set of crops and duration for which crop area in absolute term and percent has been discussed at the beginning of the study. It is interesting to note that the yield of all the types of crops has increased during the study period, although in different proportions. It is indeed good news as there is a limit to increasing the cultivable land, for land being a limited natural resource. In such a scenario, increasing productivity is the only alternative way. Overall, the increase in yield reflects growth in agriculture and also the reason behind the growth in the area of certain crops over others. After keeping a portion of edible crops aside for household consumption (for humans, animals and seed), farmers sell the remaining part in the market. Over the years, an increase in yield means that the farm families are selling a higher proportion of output in the market. Thus, a higher degree of purchase and sale of input and output is as per Marx an aspect of growing commercialisation.

An obvious question at this point is that how did the increase in yield become possible. To put differently, what are the factors that induced the yield. In the crop area under study, increased seed replacement with high yielding seeds, as shown in Table 5 and an increase in crop area treated with fertiliser, as shown in Table 6 and Figure 1, are the prime movers, who worked together, along with increase in irrigation facility, use of micro-irrigation technique, adequate rainfall, and residual factors.

VI

CONCLUSION AND POLICY IMPLICATION

The paper provides insights on the changes in cropping pattern in Rajasthan in the last 60 years. State level statistical data analysis reflects that within cereal cultivation, the cropping pattern has moved away from low value towards high-value crops. To be precise, the superior cereals namely wheat and rice gained area, while coarse cereals, namely jowar, barley, small millets and bajra (in per cent) lost area. Together, the net sown area of all the cereals has come down by close to 10 per cent while pulses area rose close to 7 per cent in the past six decades. This shuffling of the area has kept the overall foodgrain crop (cereals and pulses) area stagnant at around 50 per cent of the cropped area which is an indication of the traditional nature of the agrarian economy of Rajasthan.

At the same time, dedication of the other half of the total cropped area for cultivation of non-food grain crops for sale in the market points towards commercialisation of agriculture in the state. In the non-food grain category, oilseeds area jumped from 5 per cent to 17 per cent in the last six decades. Also, high-value horticulture crops such as fruits, vegetables (especially guar), spices, medicinal and aromatic plants and flowers have gained area in the recent years of 21st century. Such shift reflects a conscious move among farmers to grow cash crops and with it to move towards profit making farming. The next change that has occurred in the agrarian landscape of Rajasthan is the way the crops are being grown. The study found that farmers are increasingly using high yielding seeds as evident from a surge in seed replacement rate of 18 crops. Likewise, the tendency of applying fertiliser has increased in both irrigated and unirrigated area and in six crops, to be specific. Higher use of technological input had a remarkable effect on the yield of almost all crops.

To sum up, the change in cropping pattern indicates a preference among farmers to grow cash-rich non-foodgrain crops for sale over cereals. According to Marx, such an increase in area under cash crops is an indication of the commercialisation of agriculture. A rational farmer is bound to take such decision to fulfil her/his financial requirement in an economy driven by money. Such change can be interpreted as agricultural development. At the same time, an increasing change in the direction of non-edible horticulture crops should not jeopardise foodgrain availability in the long run. Replacement of a diversified cereal oriented cropping pattern with the one concentrated towards fewer cereals has an adverse effect on both soil and human health. Presumably, the nutritional benefits in the food plate received from coarse cereals are now getting replaced by a wide range of fruits and vegetables which are extensively grown by farmers of Rajasthan. However, how many urban and rural poor and middle-class households possess the purchasing power to fulfil the nutritional requirement and does so, which is otherwise obtained from a diversified cereal plate, is a question that requires further research. In such a scenario, policy intervention is required to ensure food security. For preventing reduction of foodgrain area from the present level, the government must offer adequately remunerative minimum support price (MSP) of cereals and pulses to the farmers to maintain the adequate availability of foodgrain at per head level in the long run. Moreover, ensuring that farmers receive MSP is equally important.

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