

Cropping Patterns in India: Spatial and Temporal Analysis

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Abstract

Indian agriculture is facing a second phase of change since nineties due to introduction of globalisation and liberalisation. The processes of globalisation and liberalisation, equipped with the information and communication technology have brought some structural changes in the Indian agriculture. Phasing out of subsidies from agriculture and restrictions of distribution of food grains under public distribution system to a small fraction of population has brought down the purchasing by government agencies. This has led the farmers to think of changes in the crops grown since the time of green revolution. It is assumed that the area under traditional crops like wheat and paddy will go down and area under crops like maize, cotton, pulses and oilseed will increase. The present paper based on ICRISAT data attempts to test this hypothesis but surprised to find out that no such major change has occurred in the cropping pattern of India.

Key words: Cropping pattern, globalisation, liberalisation, agricultural subsidies

1. Introduction: Agriculture is the backbone of India economy, as a large proportion of Indian population is dependent on it. Indian agriculture has been revolutionised after introduction of new approach to agricultural practices with the provision of high yielding varieties of seed, chemical fertilisers, insecticides, pesticides, farming machines etc. during mid-sixties which increased output manifold in food grain production. Though the increase in production was need of time and helped us in attaining self-sufficiency in food grains but there were some limitations too. The high yielding varieties of seed were limited to few crops. The new approach too was limited to the few areas which were able to take the economic benefits of it. The massive use of fertilisers, pesticides etc and extra extraction of water from ground for surface irrigation, over a period of time, started showing adverse impacts in terms of salinity,

alkalinity and decline in soil fertility. After nineties, due to globalisation and liberalisation it was assumed that Indian farmers would get access to international market and the agricultural decisions would be determined by external trends which would lead to a wave of changes in the agricultural practices in India. In this background the present paper attempts to explore the changes in the agricultural practices at district level in terms of areal expansion, cropping patterns, production and yield of important crops in India.

2. Review of Literature: Cropping pattern is one of the most researched topics by economists, geographers, agriculture scientists and other social scientists since the introduction of agriculture innovations in India. Singh (1962) drawn our attention towards the issue that economic criterion was not the major determinant for growing of crops in India. Based on a primary survey, Shetty and others (2007) pointed out that the area under cotton, vegetable and maize has increased but these crops are grown in poor soils resulting in poor output, so need better inputs. Ghosh (2011) had identified that though the focus was on food grains production in India, but later on it attracted farmer's attention towards non-food grain crops. It has been highlighted by Uma and others (2013) that the farmers are losing interest in agriculture, which will adversely affect the food security of the country. Sun and others (2015) concluded that shifting to cash crops not only increased the returns but also improves **productivity of water**. The available literature covers a wide range of issues pertaining to cropping pattern but the most of the studies on cropping patterns in the country have been based on state level data or at micro level for a limited area. Also, the most studies are based on the early part of introduction of liberalisation and globalisation. The present paper will explore changes in the agricultural practices in India based on district level data.

3. Aims and Objectives: The study has following objectives –

- i) To find out the current spatial pattern of area, production, and yield of some of the major crops grown in India;
- ii) To highlight the temporal patterns of area, production and yield of some of the major crops grown in India;
- iii) To suggests some relevant policy implications of these changes.

4. Database and Methodology: To understand the changing agricultural practices in India, data for areal expansion, production and yield pertaining to major crops grown at district level in the country are required. Such data are published by The International Crops Research Institute for Semi-Arid Tropics (ICRISAT). The selected crops include- wheat, paddy, maize, pearl millet, pulses, sunflower, soybean, oilseeds, and groundnut. These data are available for 311 districts of 20 states of the country, the newly carved districts are merged in their original district for the purpose of comparison and only 311 districts have been mapped (Table 1). In major crops like wheat and rice data for all above mentioned districts are available from 2001 to 2017 but data on other crops are not available for all districts and all years. Therefore, cartographic works have been done accordingly.

Table 1 : State wise number of districts selected for analysis

State	Number of Districts	State	Number of Districts
Andhra Pradesh	11	Madhya Pradesh	37
Assam	10	Maharashtra	26
Bihar	11	Orissa	13
Chhattisgarh	6	Punjab	11
Gujarat	18	Rajasthan	26
Haryana	7	Tamil Nadu	12
Himachal Pradesh	10	Telangana	9
Jharkhand	6	Uttar Pradesh	46
Karnataka	19	Uttarakhand	8
Kerala	10	West Bengal	15
		Grand Total	311

5. Discussions and Results: Changes in agricultural practices over period, is essential to maintain the level of development in the sector. Though a number of crops are grown in India, but these are not grown across the country uniformly. Some crops are grown over a large area in some districts. Such crops have been considered for further analysis.

5.1 Paddy: Paddy is the most important crop grown across the country and even 3 crops are harvested in some parts of the country. The area and yield seems to be gradually rising but the production has increased at more pace than areal expansion with intermittent fluctuations. The highest production of paddy was recorded in 2016 (Figure-1).

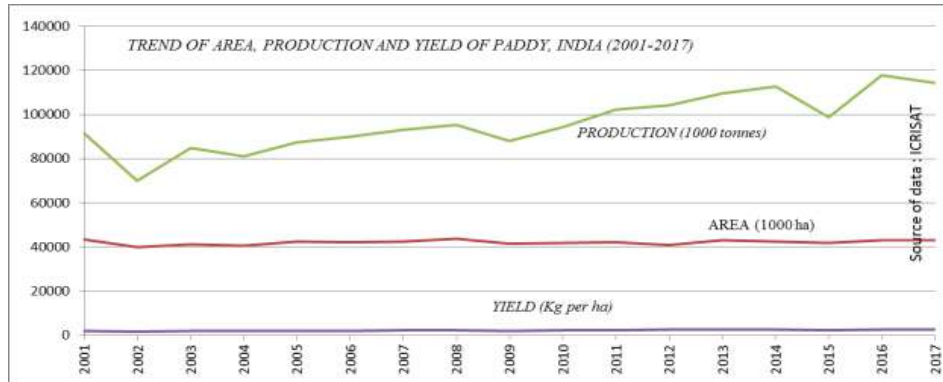


Figure 1

The percent change in the area, production and yield of paddy shows a peak and valley pattern, with two prominent positive peaks in 2003 and 2016. The negative lowest peak was in 2002. The percent water deficit curve (2002-2015) also forms peak and valley pattern but in a reverse way. When there is a peak of all the three elements, the water deficit forms a valley with negative percent change (Figure 2).

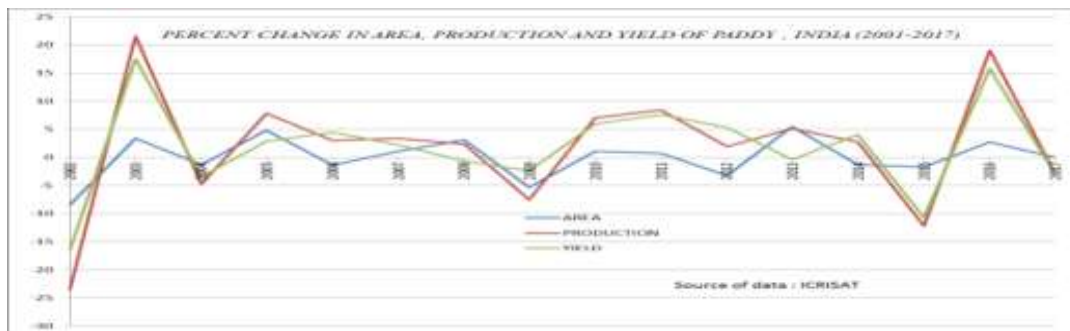


Figure 2

The map depicting district wise percent change in the area under paddy shows large patches of light red colour indicating 25 to 125 percent decrease in south India. Such districts are found in Kerala, Karnataka, Tamil Nadu and Maharashtra (Figure 3). It is observed that there is an increase in the area under paddy crop in some districts of the country. The area under paddy crop showing an increase more than 1000 percent in are 5 districts – Raisen, Jhalawar, Sehore , Vidisha, and Hoshangabad in Maghya Predesh. Such a high increase is due to rapid expansion of paddy cultivation in these districts during 2001-17. Paddy cultivation in this area was quite low earlier.

The map depicting change in production of paddy in India is like mosaic of colours and two colours are prominent. One is dark green which shows increase and the other is orange shows a decrease. There are 7 districts where the increase in production is more than 1000 percent. They are the 5 districts mentioned above and 2 more districts of Datia and Narsinghpur. The districts with decrease in production form a long pattern in form of a belt from Maharashtra in the north to Kerala in the south (Figure 4).

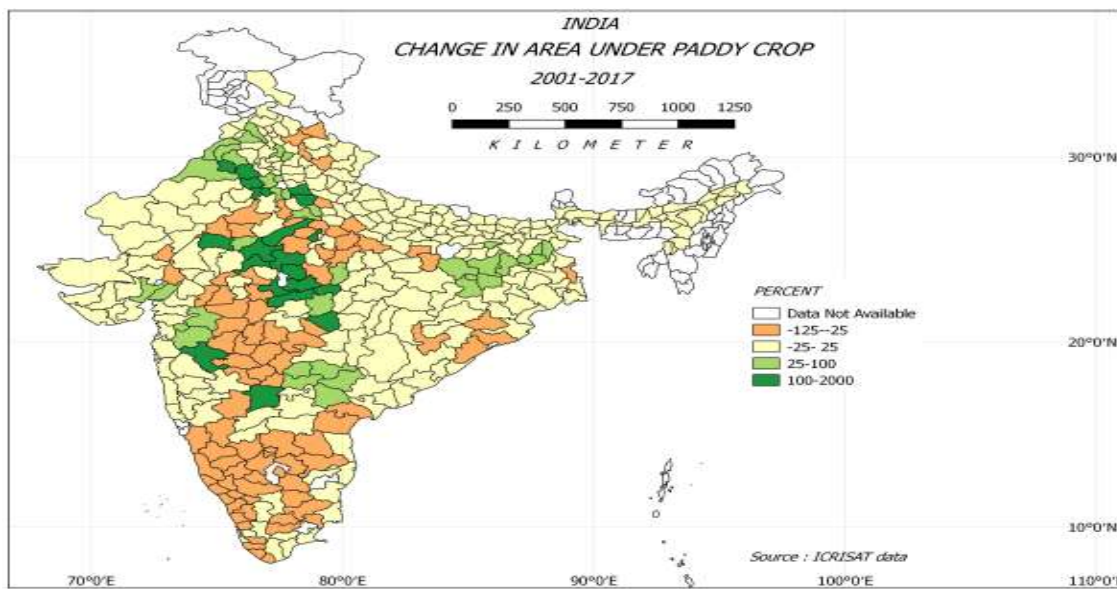


Figure-3

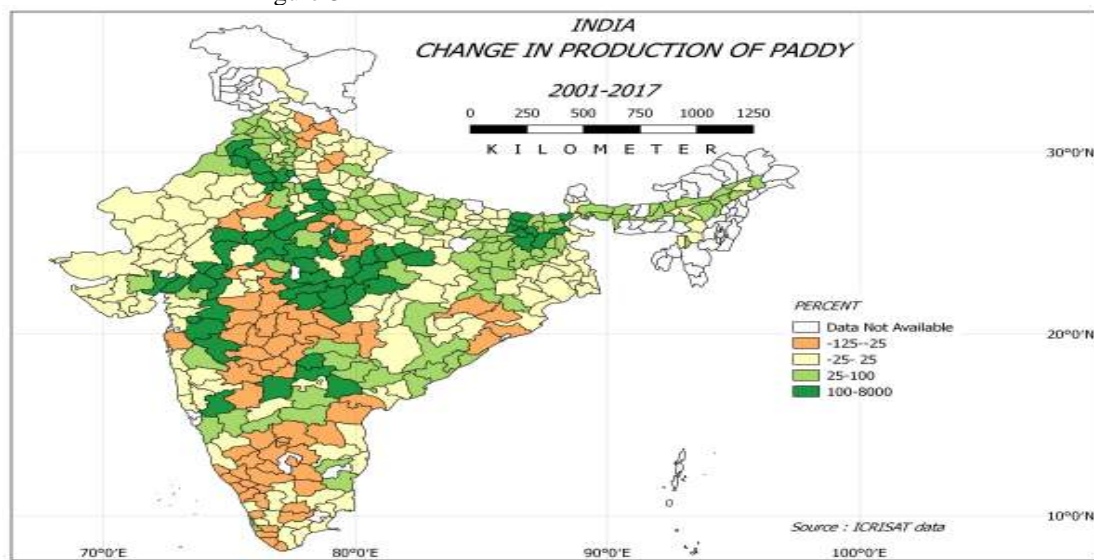


Figure 4

5.2 Wheat: Wheat is the second main crop mainly grown in fertile northern Indian plain, though it is also grown in some districts located in plateau and hilly regions also. As per the available data, there is an considerable increase in the total area and yield of wheat during 2001 to 2017 in the country. Production of wheat with little bit fluctuations has also increased considerably during the same period (Figure 5). It has peaked in 2013, then declined in 2014 and increased again in 2016.

The percent change in all the three aspects- area, production and yield shows a peak and valley trend. Peaks are formed in 2003, 2006, 2010, 2013 and the last and highest one is in 2016. The valleys are in 2004, 2008, 2012, 2014 and 2017. During all these years the negative change i.e. maximum decline of area under wheat and production was recorded in the year 2014(Figure 6). The percent change in water deficit is also plotted from 2002 to 2015 on the graph, which shows that the peak and valley pattern is almost reversed. It indicates that the area, production and yield are increasing in positive direction in the years of deficit barring few exceptions. It seems that the water deficit did not affect the area, production and yield in the year of deficit, affected it next year of deficit.

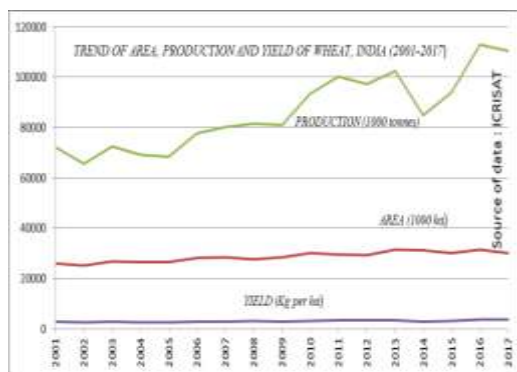


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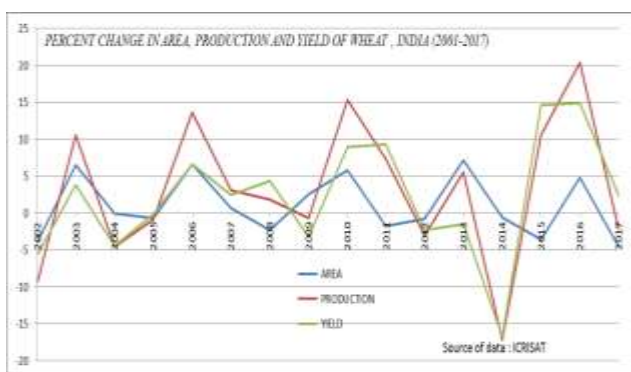


Figure- 6

At district level, changes are there in both directions- positive as well as negative. A cluster of districts of green colour indicating positive change in area under wheat cultivation can be easily identified on the map, along the border of three states - Gujarat, Maharashtra and Madhya Pradesh. The highest increase in the area under wheat crop is recorded in the districts of Dangs followed by Panchmahal, Rajkot and Sundernagar of Gujarat. The belt also include Nagpur and Dhule districts of Maharashtra and continued up to Madhya Pradesh which includes districts of

Jhabua, Ratlam, Ujjain, Khargone, Rajgarh and Khandwa (Figure 7). The wheat belt in Madhya Pradesh is known for its high demanding Sarbati brand of wheat. The area under wheat crop has increased more than 100 percent mainly in the districts of Gujarat, Maharashtra, Madhya Pradesh and Rajasthan during 2001-17.

The area under wheat crop has declined in 134 districts recording less than 100 percent. The continuous belt of districts, where it has declined between 25 percent and 100 percent, starts from the Chickmagalur of Karnataka to Tinsukia of Assam. Production of wheat has increased in the all above mentioned districts where there were an increase in the area under wheat crop. The highest increase in production was reported in Ujjain district (more than 1300 percent) followed by Rajkot (1200 %), Jhabua (1200%) and Panchmahal (1100 %).

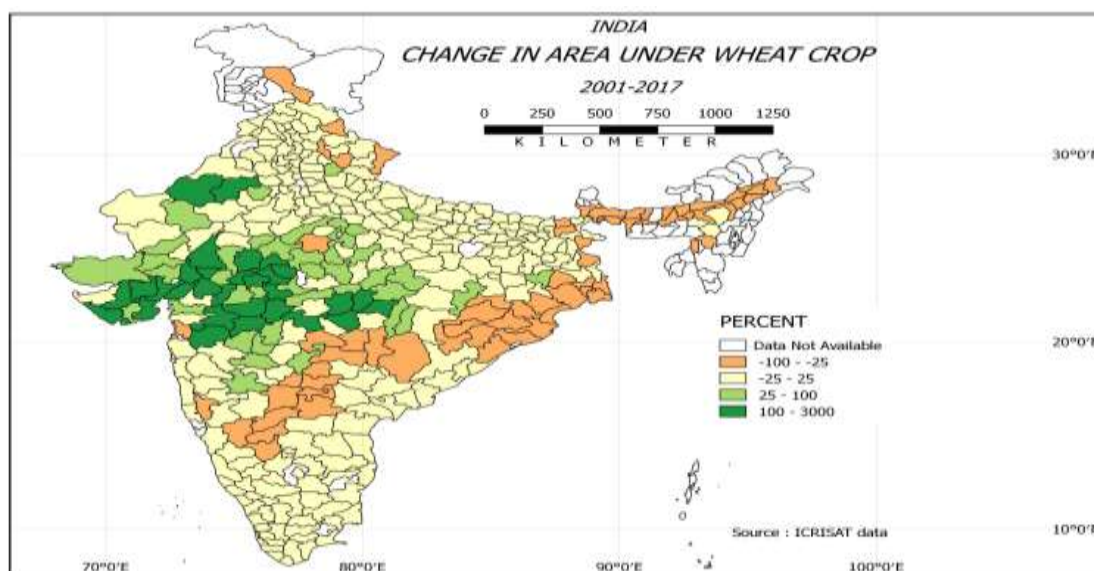


Figure 7

The belt of increase in wheat production has followed the same pattern as in the case of the area under wheat crop. Districts showing many times increase in wheat production are clustered on the common borders of Madhya Pradesh, Maharashtra, Gujarat and Rajasthan. The production has declined in those districts where the area has declined (Figure 8).

As far as yield of wheat is concerned, it has increased in the districts of Uttar Pradesh, Madhya Pradesh, Maharashtra, Gujrat, Bihar, Jharkhand, Orissa, Andhra Pradesh and Rajasthan. There is a large cluster of districts in Madhya Pradesh, where the increase in yield was between 200 to

300 percent (Figure 9). In two districts (Ajmer and Chhitorgarh) of Rajasthan, the increase in yield was recorded more than 1000 percent. This phenomenal increase in production in two districts is attributed to the introduction of sprinkler irrigation in these districts during the later part. Earlier, the production was quite low in these water deficit districts.

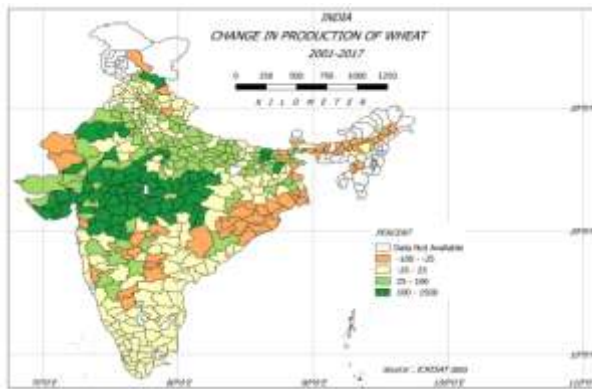


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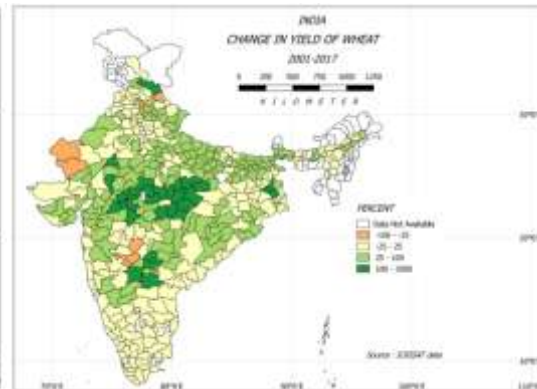


Figure 9

5.3 Maize: Maize is one of the important cash crops in India, and widely grown. The area and the yield of maize show a slow growth while there is a sharp increase in production with intermittent fluctuations. The increase in production in 2017 is quite sharp (Figure 10). The percent changes in production and yield forms peaks and valleys pattern. The peaks of more than 30 percent increase in production are formed in 2003, 2007 and 2010 and lesser peaks in 2013 and 2016(Figure 11). The percent change in area also forms similar peaks but the height remains less than 10 percent. The water deficit curve also forms peak and valley pattern but in reverse order. It means when the yield and production are forming peak, the water deficit curve will form a valley, which will result in lower production and yield in the following year.

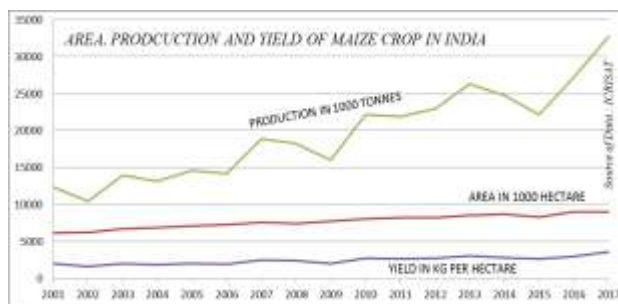


Figure -10



Figure 11

There is a clear cut north-south division in terms of changes in the area under maize crop. There is decrease in the districts of northern India, while increase in the districts located on southern plateau. There is more than 1000 percent increase in the area under maize crop in 15 districts including South Arcot, Uttara Kannada, Kaddapa, Chickmagalur, Kurnool, Hamirpur etc. Most of these are located in Tamil Nadu, Andhra Pradesh, Karnataka and Maharashtra (Figure 12). There is almost 100 percent decrease in the area under maize crop in Sikar, Bharatpur, Dholpur, Jaisalmer, Jodhpur, Nagaur and Barmer districts of Rajasthan. The pattern of distribution of districts with respect to change in production of maize is similar to the area under maize, but green colour showing increase pattern is more dominant on the depicted map (Figure 13). It means there is a wide spatial expansion in increase in production of maize in India particularly in its southern part.

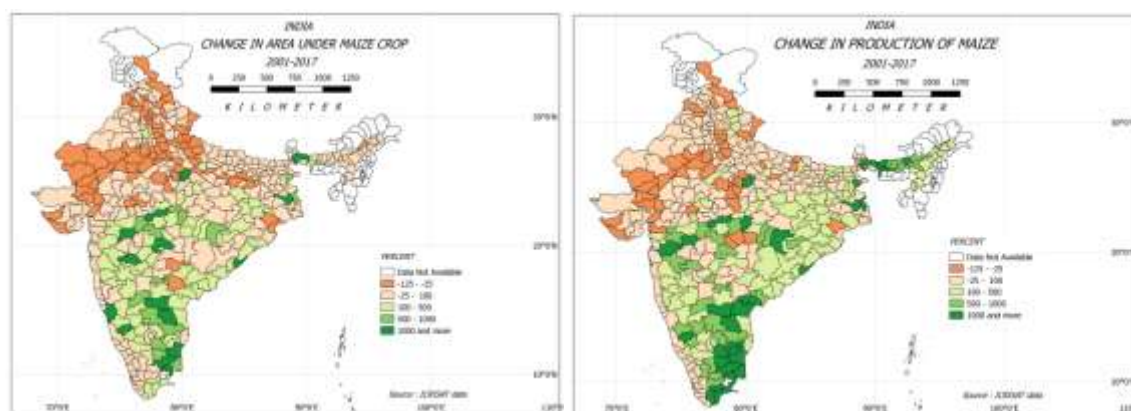


Figure -12

Figure- 13

5.4 Pearl Millet: Pear millet, locally known as *Bajra* is a coarse grain grown in areas of low rainfall was considered a crop of poor people. However, it used to be part of diet in many parts of the country before arrival of high yielding variety of wheat crop. It is nutritious and easily digestible food grain, but in the race of modernisation we lost it from our diet. The yield and production of pearl millet are always lower than wheat and paddy crops (Figure 14). There is a decrease in the total area under pearl millet crop but up and down fluctuations are there. The total production of the crop in the country shows more fluctuations with peak in 2003, 2010 and 2011. The percent increase in the production and yield of the crop spiked in 2002 and 2009(Figure 15). During the last 16 years, there was decrease in the total area under pearl millet

crop in most of the districts across the country. The decrease in area is primarily due to shifting towards wheat and paddy crops with introduction of irrigation facilities. Guna and Rewa are the two districts where increase in the area under pearl millet was more than 1000 percent (Figure 16). As a result, more than 1000 percent increase in production has been recorded in these two districts. Two more districts - Mysore and Ananthapur also reported more than 1000 percent increase in production of this crop.

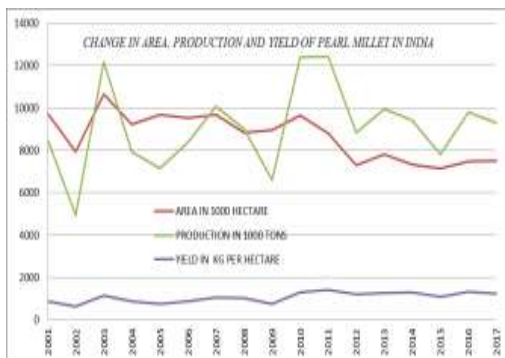


Figure- 14

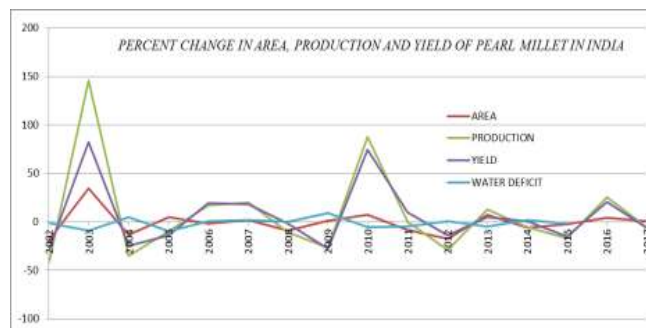


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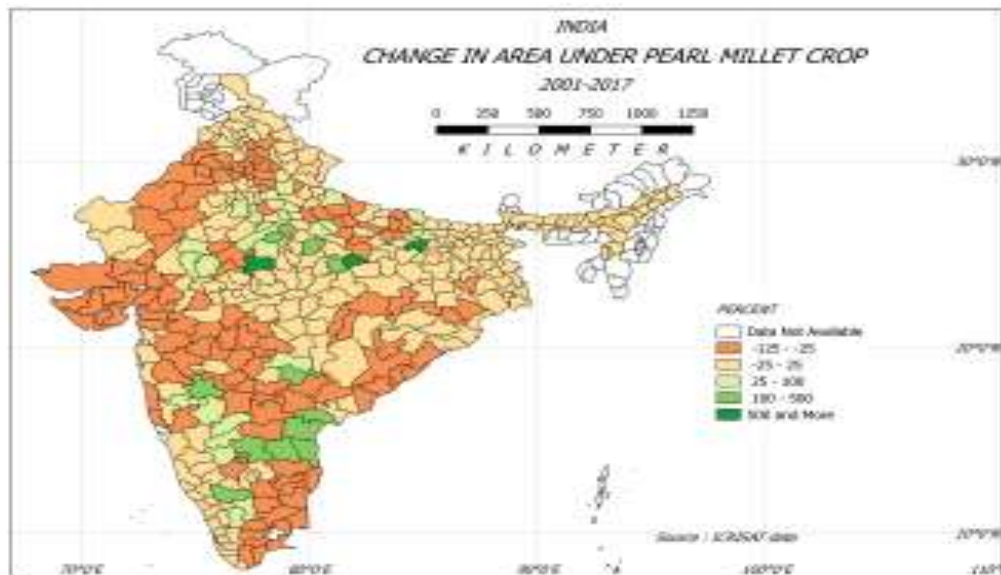


Figure- 16

5.5 Comparison of Wheat, Paddy, Pear Millet and Maize Crops: It is observed that the area under Paddy is much more than the wheat crop but gap is slightly decreasing. The total area under paddy in the country almost remains same with minor fluctuations, while the area under

wheat crop has increased during 2001-17 (Figure 17). Area under pearl millet has gradually decline, while the area under maize is slowly increasing. In spite of larger area under paddy as compared to wheat, the difference in the production is smaller and gap has further narrowed down recently.

The total production of maize is also increasing along with area under this crop. The total production of pearl millet has reached its maximum in 2010, and there after decreasing slowly (Figure 17). The reason for less difference in production of rice and wheat, in spite of many differences in area expansion is due to much higher yield of wheat crop. There is dip in the yield of wheat in the year 2014(Figure 18). The yield curve of maize has increase in the last two years after many fluctuations. The yield of pearl millet is the lowest with nominal increase.

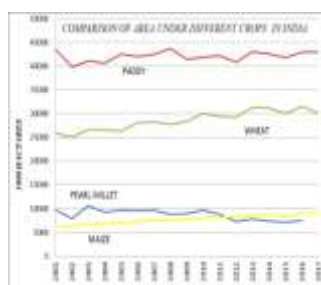


Figure-16



Figure-17



Figure-18

5.6 Pulses: Pulses are rich source of protein and an important staple for vegetarian. It is consumed in each household in the country. It is only in the case of pulses that the area under a crop is higher than the production of that crop (Figure 19). It is primarily because of lower yield of the crop. There are clusters of districts in the southern plateau where the area under pulses has declined. There are few districts with some increase in area under pulses (Figure 20).

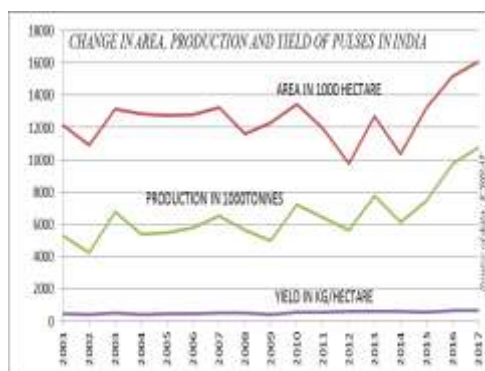


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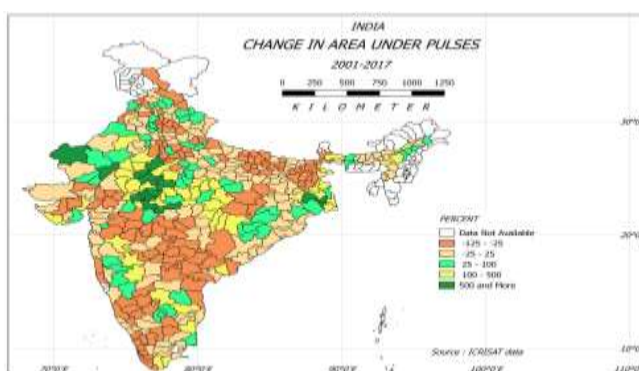


Figure-20

5.7 Oilseeds, Sunflower, Soybean and Groundnut: Oilseeds are very important component of diet and consumed in all most all households in some quantity in India. Besides mustard seeds, sunflower and soybean are grown in some parts of the country as cash crop. The area under soybean increased in 2005, 2010 and 2013 but decreased in the intermittent years. The area under sunflower has recorded a steep and continuous increase. The area under groundnut and oilseeds is quite low and increased slightly from 2001 till 2005. Thereafter the area under these two crops have shown continuous decreasing trend (Figure 21).

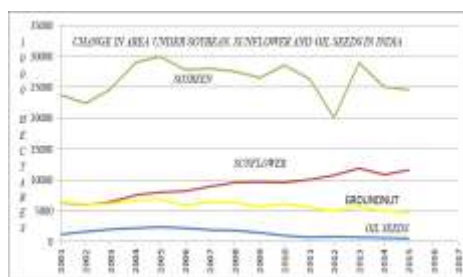


Figure 21

An attempt is made to find out the correlation between the area under three major crops (dependent) and GDP and annual rainfall (independent). The associations have been tested with the null hypothesis. Since data pertaining to all districts was not available, only 41 districts were selected for testing the relationship of the major crops with two independent variables. There is significant positive correlation between area under paddy crop and rainfall while correlation between area under other crops and rainfall is not significant (Table 2). The null hypothesis that there is no relation between area under paddy crop and rainfall has been rejected. It means rain fall has a significant role in cultivation of paddy even though availability of adequate supply of irrigation facilities. There is significant positive correlation between area under wheat crop and Gross Domestic Product from cultivators. The null hypothesis has been accepted in the case of areas under two other crops and the GDP. It means GDP has little roll in the cultivation of paddy and maize crops.

	Area under crops				Area under crops		
	<i>Paddy</i>	<i>Wheat</i>	<i>Maize</i>		<i>Paddy</i>	<i>Wheat</i>	<i>Maize</i>
r (with GDP from cultivators)	0.057	0.293*	0.095	r (with Rainfall)	0.451*	-0.232	-0.074
*significant correlation							

Conclusions:

With the introduction of globalisation, liberation and policy to facing out of subsidies from agriculture sector it was considered that favourable conditions may change the cropping patterns in India. It was expected that there will be structural changes in the form of shift from traditional wheat and paddy cultivation to other crops. The data pertaining to area, production and yield of selected crops during 2001 to 2017 do not support the above hypothesis. Even today, a large area is devoted to the paddy and wheat crops in the country. The area under most of the traditional crops is increasing, which indicates the increasing intensity of land use. More and more farmers are following the pattern of Punjab and Haryana where paddy and wheat are dominant crops. It has been markedly observed in the districts of Madhya Pradesh, Maharashtra, Gujarat, Karnataka and Andhra Pradesh. Increase in irrigation facilities has also facilitated the expansion of the areas under wheat and paddy crops to new districts. The successive peaks and valleys indicate that the monsoon rain is still playing important role in shaping the cropping pattern in India. Soybean was the main crops of many districts of Madhya Pradesh, but the area under this crop has not shown significant increase. The area under sunflower crop has shown some increase in some districts, while area under oilseeds has lately decreased. Area under pulses has shown some sharp increase from 2013 onwards, if this trend continued for some more years, it may result into higher production of pulses in the country. But the yield of pulses is quite low, which needs to be noted by the agriculture scientists to develop high yielding seeds so that the farmers can get their share of benefits by devoting more land to cultivation of pulses. Maize is another crop which shows slow rise in area but steady rise in production and yield. The year 2014 was the year of low production, afterwards some changes are seems to be taking place. It means

some more years are required for structural changes in Indian agriculture by adding market forces to act.

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6Source of data <http://data.icrisat.org/dld/src/additional.html>