DOES GREEN REVOLUTION CREATED MONO – CROPPING PATTERN IN INDIA?

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Abstract: Global agriculture faces the challenge of sustaining livelihood of 60 percent of the global population apart from feeding nine billion people, fighting with hunger and elimination of malnutrition, preserving the environment and responding to climate changes. Over and above, Indian agriculture is facing shortage of labour, escalating input-cost due to reduced farm subsidies, absence of assured prices for farm outputs, reduced investment for irrigation facilities, unpredictable climatic change and increased risk in production and productivity. In the early-Independence Era, India has faced severe food crisis. In response to the crisis, government had adopted green revolution strategy to increase the food availability. To a larger extent Green Revolution has succeeded in raising the food production to the level of national self-sustenance. However, the continuance of the strategy appears to have damaged the crop diversity by depleting the non-cereal crops production. After the Green Revolution, wheat and rice continue to occupy major share in the gross cropped area in each of the major crops producing states in India and there is extensive increase evidence on crop area shifts from coarse cereals and pulses to rice and wheat. Thus, green revolution strategy is criticized to have culminated into mono-cropping, decrease of land fertility, increased vulnerability to climate change, increased subsidy burden, unviable agricultural enterprise and inefficient land use pattern. These specific issues make the Indian agricultural practices unsustainable in the coming days. The study explores the change in cropping pattern in the post green revolution and verifies the hypothesis of wheat-rice dominated mono-crop pattern. To sum, this study argues for the crop diversification in agriculture as it has positive implications for climate change adaptation, farm subsidy reduction and diminished risk in farm enterprise which may help sustain agriculture. The present study shows the trend on diversification has decreased and increased with more fluctuations and it does not linked with livelihood by observance of pulses, cereals has decreased its share of area and only the rice-wheat has increased and increasing. It will not double the farmers income.

Introduction: Indian economy is always giving prime importance to the Indian agriculture and it is considered as a hard process to deal with uncertain factors of weather and market condition[1]. It 54.6 percent of rural households depend on agriculture for their livelihood (Census 2011)[2]. India is the second largest producer of rice, wheat, sugarcane, cotton, and groundnut. In 2017 – 18, total food grain production was estimated at 275 million tons and the production is expected to be higher than the estimated amount. In the new millennium, India still has many growing concerns in agriculture. Additionally, it indicates the demand for India is to fill the stomachs of the growing population and have to sustain the livelihood. As Indian agriculture is facing a shortage of labor due to rapid urbanization, escalating input – cost due to reduced farm subsidies, the absence of assured prices for farm outputs, reduced investment for public irrigation facilities, global climate change induced risk and uncertainty in production and productivity of main crops, on one hand, making both agriculture and sustained economy is equally important on the other hand. Comparing the pre and post independent era, the population is exploding every year but there is no significant increase in alternative occupations in agriculture. By introducing the Green revolution as a strategy to increase the food productivity, availability and sustainability the best possible way of National self-sustenance was carried out. Both of

the plans had the same intention but with different intensities. This eventually made green revolution to be successful, but it is misleading the agriculture towards mono-crop culturing. The green revolution has paved way for the introduction of new chemicals, fertilizers, pesticides, foreign agricultural equipment, altering food habits, occurrences of new diseases etc. where the agricultural practices have changed.

Livelihood and Diversity: Diversity is a macro-economic reform highly linked with the livelihood which expands farmer's income, employment, reduce agricultural risks and reduce poverty. These are the major challenges faced by the economy and the emerging issue is diversity which causes the livelihood. The study has argued for the increase in diversification by eliminating the mono-crop culture. Because, mono-cropping affects the livelihood and increase the agricultural risks among farmers and the decrease in share of area among the crops. In the Post Green revolution, there has been a major changes happened which brought diversity and mono-cropping are the two factors affecting the livelihood in India. The consequence of mono-crop has brought more risks involvement and the decrease in contribution of agricultural sector which moves to unsustainable practices. Diminishing crop diversity plays a negative role in the Indian economy. Diversification is the important factor which may increase or decrease the effects in agriculture only by the proper planning in utilizing the crops and land. A decrease in crop diversity and dominance of mono-cropping to other crops is leading the changes in crop pattern, farmers income, employment and a continuous decline in the share of agriculture and allied sectors from 18.6 percent in 2013-14 to 17.4 percent in 2016-17. By continuance of this strategy of mono-cropping culture, it will affect the agriculture scenario. It will not be supportive of the next generation population which results in less arable land, low crop production, decrease in food availability, decrease in agricultural based livelihood, decrease in employment, decrease in farmers income, decrease in standard of living, increase in hunger and malnutrition, changing food pattern and turns into unsustainable. As a single crop is given importance, obviously the other crops lose their significance and thereby changes in socialistic pattern, eventually altering the whole economy. To address the issue of changes in crop pattern due to the decrease in crop diversity is the major challenge to the Indian agriculture. Crop diversification is to attain national goals like employment generation, reducing risks associated with market, prices, minimizes risk in farming, arresting the degradation of natural resources and optimizes the use of land.

Review of Literature: Mann (2017)[3] study has entitled *Cropping pattern in Punjab* argued that the crop pattern changed in Punjab due to the two major reasons, i.e., In green revolution rice-wheat were occupied the other crops area and major increase in Minimum Support Prices (MSPs) of pulses, there is negligible interest on the part of the farmers in adopting pulses. With the advent of the green revolution, the area under rice and wheat was expanded and the area occupied by all the other crops has reduced drastically. The study concluded that crops with a higher value of output which are suitable for cultivation in Punjab must be selected and effort must be made to expand the area under those crops. In Punjab, for more crops, it requires a greater initial investment than wheat or paddy. Additionally, the regulated markets are not efficiently utilized excluding wheat and paddy. The study emphasized that the need for e-NAM has to be utilized well for the state and also it will be beneficial to the farmers.

Joginder Singh, Sindhu R. S. (2004) [4] *Factors in Declining Crop Diversification – Case Study of Punjab* had entitled that agricultural production in Punjab has been declined because of the diversity in the cropping pattern and the emergence of wheat – rice specialization over the past few decades. Also, the dominance of wheat-rice system has led to the drop in the over-exploitation of groundwater resources and the decline in soil fertility. The study says that after the green revolution there was an improvement in crop yields, intercrops shifts particularly from low – value to high – value wheat – rice crops and it is considered as a vertical expansion of cultivated area. The study highlights the green revolution context in two views such as wheat – rice was mainly responsible for the growth in total value of production and wheat – rice was the most important factor for the decrease in diversity.

Malik D.P., Singh I.J. (2002) [5] *Crop Diversification – An Economic Analysis at Haryana* has measured the extent of crop diversification at Haryana District by various measures of diversification like entropy

indices and crop diversification. Continuous Wheat – Rice rotation were resulted in depleting of underground water resources. Study on other districts indicated that specialization in crops was due to the absence of risk. The study had analyzed the outcomes of the crop diversification in the view of farmers in Haryana District. The rising crop yields have not improved the farmer's income level and have not decreased their difficulty in sustaining their family. And therefore the study had concluded that farmers have little income to invest in farming and crop diversity.

Most of the literatures have studied a micro level analysis on crop diversification that included change in cropping pattern, factors affecting crop pattern, implications and significance of diversification on risks involvements. The studies have shown that mono-cropping is playing a negative role in all the places around the World (Jogindher Singh & Sidhu, 1990). This study contributes test the hypothesis on mono-cropping. So, the study explores the factors leading to the mono-cropping that is antithetical to crop diversity. The study has further explored the long-term consequences of green revolution in four phases such as Pre Green Revolution period, Green Revolution period, early reform period and Later Reform period with the significant changes happened in the respective period.

Study Methodology: The study covers the entire country for analyzing the diversification and based on this, the data was collected from Ministry of Statistical Planning and Implementation, RBI Bulletin, Agricultural Glance at 2017. Area of the crops and total cropped area are the study variables area of the crops from the time period of 1950-51 to 2013-14. To analyze the changes in total cropped area, area of the individual crops, change in cropping pattern and diversification, the study has used diversification index by the considering the above factors and it is called as Gibbs Martin Index (GMI) to calculate the diversification.

Index of Crop Diversification = $1 - \Sigma X^2 / (\Sigma X^2)$
Where X stands for percentage of total cropped area occupied by each individual crop.

The study has categorized the analysis for the mono-cropping hypothesis in four dimensions as discussed above. It depicts the actual scenario on agricultural performance on each period. The study has found the changes occurred in the total cropped area, changes in cropping pattern and these changes has reflected in the reduction in crop diversity with the major factors engaged in that period of change which changed the agricultural pattern.

Pre Green Revolution Period: The years after independence, India has seen a steady decline in the production of cereals in India.[6] At the period of 1947, the Indian economic position has to develop the sustained increase in food production which supports the farmer's livelihood and the well-being improvement of agriculture. From the five year plans itself, the Indian economy has given importance to agriculture. There is a substantial increase in agricultural performance with small increase in production due to growth in the extent of irrigated land, acreage and favorable monsoons made the planners has moved to next stage on planning. But the awakened issue has made food crisis in 1960s which forced to make food available by modern technology. In this period, total cropped area has utilized properly by the traditional agricultural practice involves wooden plow, waterwheels, and bullock carts, which all these requires for all agricultural activities provided by humans and animals.[7] In India, rice area has occupied at large and it is an advantage for India to have the rice crops. Secondly, Jowar has occupied the second place after the rice and it is a waterless crop. Wheat has occupied less importance in India in the pre-green revolution period carries 9.75 (mn.hec.) in 1950-51 to 13.42 (mn.hec.) in 1964-65 increased continuously after the jowar. Jowar and bajra crop is naturally least water-consuming crop has increased in this period. This pre-Green Revolution period shows that there has an increase in crop diversification in major crops. Adding to this, the total cropped area has also increased. Increase in crop diversification which results in an increase in agricultural performance, varieties of crop and food availability, increasing the bajra and jowar which is the waterless crop increase the water availability, provides employment opportunities to the farmers, income increases and further it enhances the farmers standard of living with supporting their livelihood. To combat the crisis, the government of India has

planned to introduce new strategy in agriculture to increase the food availability to the people and the entire country which the name of strategy is called "Green Revolution".

Green Revolution Period: The purpose of this strategy in the mid-1960s has to make the country self-sufficient in food to combat crisis on the one hand while enhancing the total food grain production, crop rotation and crop sequences played an important role on the other hand. The main feature of the Green Revolution is High Yielding Varieties (HYVs), the main crop considered as wheat-rice i.e., Seed – Fertilizer – Water Technology. In this initial stage, Green Revolution has thrown into the widespread poverty reduction; prevented hunger for millions of people and its negative effects which highly on the policies that have used to promote rapid intensification to increase the food supplies which creates one of the harmful agricultural practices in India. After the Pre-green Revolution of 1964-65 to 1965-66, the total cropped area has decreased to 159.23 (mn. hec.) to 155.28 (mn.hec.) and a decrease in individual crop area has also been noted. In the Green revolution period, the total cropped area has increased. Jowar and bajra have decreased their importance and the share of the area is declined from 1980-81 to 1990-91. Cotton

Early Reform: After the implementation of green revolution, the diversity has continuously declined. Comparing to the other crops only the rice-wheat has increased. Growth of rice-wheat by technological support, price support, infrastructure support including markets and irrigation, subsistence requirements, lesser price and yield risks are those factors were made rice-wheat performance more superior than other crops. Green revolution has brought more income to the already rich and it made a wider gap between the rich and poor.[8] Due to the absence of risks, investment in farming makes the decrease in diversity. Here where the arrival of mono-cropping in high level than other crops which decreased the diversity in agriculture. Prior to the mid-1960s, crop diversification was not a popular concept in India. But now, diversification is considered as a risk management strategy which involves other crops performance also adds the advantage of mitigating price risks.[9]

Later Reform: Several studies have documented that the effect on green revolution in wheat and rice has continuously occupied the major share in the gross cropped area and the study has observed that comparing to all crops rice area has increased from 23.4 percent in 1950-51 to 31.2 percent in 2013-14 and there is extensive evidence on crop area shifts from coarse cereals and pulses to rice and wheat. Area of wheat has minimum in the year 1950-51 as 7.4 percent which drastically increased after 1966-67 as 9.2 percent and continuously it has increased up to 21.5 percent in 2013-14. This is because the growth of rice-wheat by technological support, price support, infrastructure support including markets and irrigation, subsistence requirements, lesser price and yield risks has made rice-wheat combination as much superior than other crops[10]. Considering the other crops, jowar area has declined from 11 percent in 1950-51 to 41 percent in 2013-14. Other crop area has steadily decreased because of low relative profitability is a strong factor to induce farmers not be more favorable to certain crops like coarse cereals and pulses after the emergence of green revolution. Sidhu (2004) had pointed out that the dominance of wheat – paddy system has led to serious economic, social and ecological problems such as drop in agricultural employment, over – exploitation of ground water resources. In 1950-51 the diversity level is 0.826 which the first five year plans gave importance to the Indian agriculture and it also maintained the stabilized growth in diversity in the following years and it has continuously increased up to 1953-54 as 0.835 with minimal fluctuations up to the year 1964-65 as 0.842. After the emergence of green revolution the diversity has increased at only one year in 1967-68 with the value of 0.845. Diversification in crop is continuously declined with more fluctuations and especially from 1998-99 as 0.829 to 2000-01 as 0.819 level has decreased in the diversity because of the dominance of rice-wheat crop and it shows that area for other crops is less by comparing to the other crops. The study had pointed out that the green revolution effects on crop pattern changes by the decrease in crop diversification has created a mono-crop culturing which is harmful to bring this strategy to the future has proved by this Gibbs Martin Index. The study has explained the relationships between the major factors which effects on diversification.

Crop Pattern Change and Diversity: From reviewing pre green revolution period to post green revolution period it shows that crop diversity has decreased at large number which made the rice-wheat as superior than other crops. If the change occurs in crop pattern it will effects on the less performance on other crops, its importance, lower food production, decrease in food availability, it moves the farmers livelihood to negative extent which results in risks farming, decline share of agriculture by this change in crop pattern and it finally results in the decrease in crop diversity is the harmful position to the Indian agriculture which may have the chance of losing the sustainability. The study has revealed the changes in crop pattern in four ways such as Pre Green Revolution, Green Revolution, Early Reform and Later Reform by considering the major crops namely rice, wheat, jowar, bajra and cotton has substantially changed its cropping pattern. By this trend, it reveals that rice and wheat has largely increased by comparing to other crops. Notably, in the pre green revolution period jowar has placed superior than wheat. After the green revolution, jowar the water less crop has declined and wheat the water consuming crop has increased continuously. The known fact of green revolution is Seed – Fertilizer – Water technology has performed well in the agriculture sector but pulls the other crops to lower performance except rice – wheat. The diversification takes place by the government policies, drive on other crops, market infrastructure development, price supports induce the crop shifts.[11]

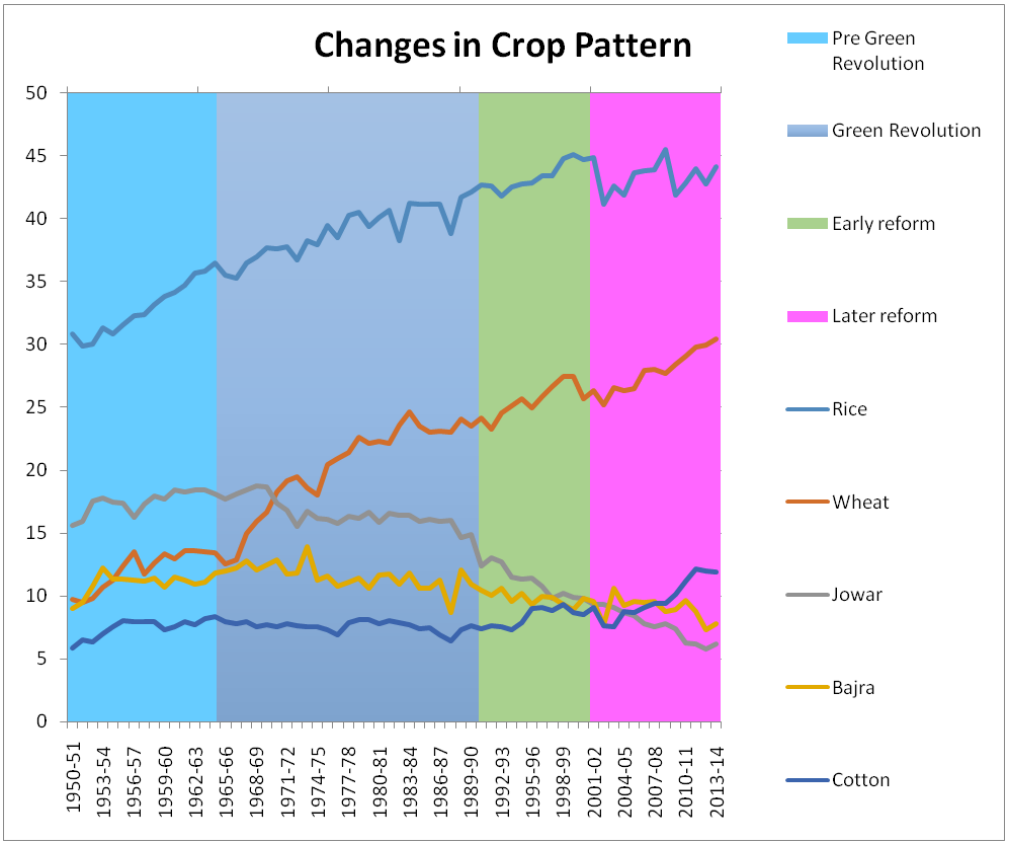

Figure 1.1: Changes in Crop Pattern
Source: Author Compiled Data

Change in Cropped Area and Diversity: The relation between total cropped area and individual crop area reflects in the diversification. The total cropped area consists of all over the crops area. The study has observed that total cropped has increased up to the third period of early reform. To the larger extent, the study reveals the major reason for the decrease in diversity may be the decrease in total cropped area. In the later reform, total cropped area has decreased at the higher level. Crop shifts may takes place in the areas with different soil problems. Due to this change in the later reform, the major crops have declined its importance and acreage. Especially, jowar, bajra and cotton have declined in the later reform.

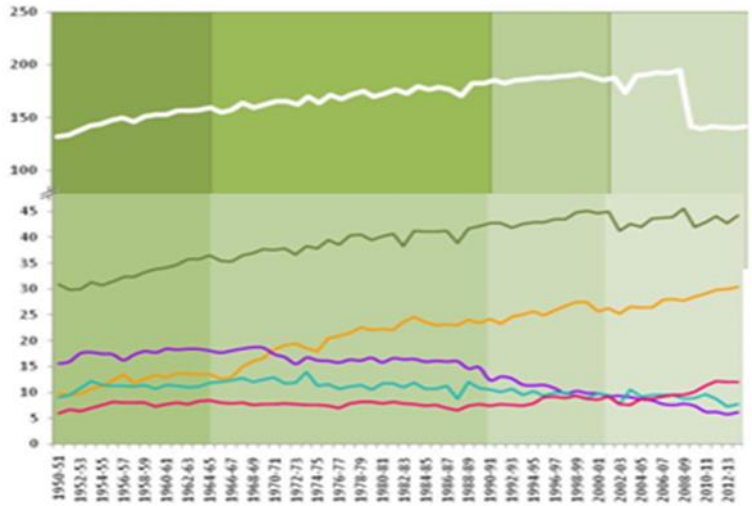

Figure 1.2: Changes in Cropped Area and Diversity
Source: Author Compiled Data

Crop Diversification and Gibbs Martin Index: Crop diversification or crop shift is a unique pattern to promote sustainability in agriculture.[12] This trend line shows the diversification level among the crops and it has analyzed the diversification has decreased. The study has found the Mono-cropping hypothesis is proves that the diversification has decreased especially by the rice-wheat combination in the Green revolution period which dominates jowar, bajra and cotton. In the later reform, the diversification is increasing because now India again concentrating on agriculture sector and after the MDG (Millenium Development Goal), Sustainable Development Goal (SDG) is the trending policy to improve the economic level with sustainability in all major factors.

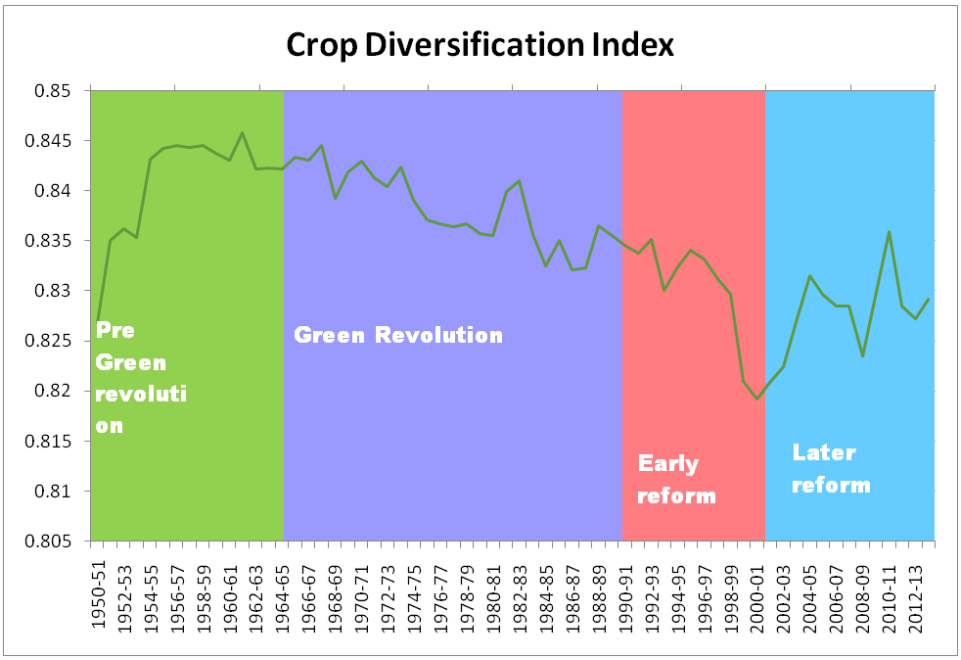

Figure 1.3: Gibbs Martin Index
Source: Author Compiled Data

Conclusion: The study intends to identify the changes occurred in the crop share in terms of area in four phases such as pre green revolution, green revolution, early reform and later reform in the time period of 1950-51 to 2012-13. The study has entirely used secondary data collected from the Agricultural Statistics at a Glance, 2017. Gibbs Martin Index (GMI) has used to identify the index of crop diversification using two variables such as area of the crops and total cropped area. In the observation of Gibbs Martin Index there is a decrease in diversity in the green revolution period and early reform. In the later reform again the diversity increases and it does not touched the aspirations on improvement of agricultural status also the index is not in the stable pattern from this sixty three years. Diversity occurred in decreasing the cereals composition i.e., uniformly all the crops has decreased its share of area but rice-wheat only increasing. The dominance is again increasing and the diversity. Mono-cropping has not supported to reduce the risks in agriculture as well as to the future generations. Therefore, diversification is not in tune with the expectations in livelihood.

Scope and Need for Further Studies: Crop diversification helps to secure farmers and alternative crops may enhance effectiveness and reduces risks. Crop diversification has been recognized as an effective strategy for achieving the objectives of food security, nutrition security, income growth, and poverty alleviation, and employment generation, judicious use of land, water resources, sustainable agricultural development and environmental improvement. Therefore, crop diversification which is considered as an effective tool to minimize the risk in agriculture practices, and reduces risk and uncertainties arising from climate changes.

Appendix:

Year	Total Cropped Area	Rice	Wheat	Jowar	Bajra	Cotton
1950-51	131.89	30.81	9.75	15.57	9.02	5.88
1951-52	133.23	29.83	9.47	15.94	9.52	6.56
1952-53	137.68	29.97	9.83	17.54	10.77	6.36
1953-54	142.48	31.29	10.68	17.76	12.2	6.99
1954-55	144.09	30.77	11.26	17.46	11.37	7.55
1955-56	147.31	31.52	12.37	17.36	11.34	8.09
1956-57	149.49	32.28	13.52	16.24	11.25	8.02
1957-58	145.83	32.3	11.73	17.31	11.17	8.01
1958-59	151.63	33.17	12.62	17.96	11.43	7.96
1959-60	152.82	33.82	13.38	17.71	10.7	7.3
1960-61	152.77	34.13	12.93	18.41	11.47	7.61
1961-62	156.21	34.69	13.57	18.25	11.28	7.98
1962-63	156.76	35.69	13.59	18.41	10.96	7.73
1963-64	156.96	35.81	13.5	18.38	11.1	8.22
1964-65	159.23	36.46	13.42	18.06	11.83	8.37
1965-66	155.28	35.47	12.57	17.68	11.97	7.96
1966-67	157.36	35.25	12.84	18.05	12.24	7.84
1967-68	163.74	36.44	14.99	18.42	12.81	8
1968-69	159.53	36.97	15.96	18.73	12.05	7.6
1969-70	162.27	37.68	16.63	18.61	12.49	7.73

1970-71	165.79	37.59	18.24	17.37	12.91	7.61
1971-72	165.19	37.76	19.14	16.78	11.77	7.8
1972-73	162.15	36.69	19.46	15.51	11.82	7.68
1973-74	169.87	38.29	18.58	16.72	13.93	7.57
1974-75	164.19	37.89	18.01	16.19	11.29	7.56
1975-76	171.3	39.48	20.45	16.09	11.57	7.35
1976-77	167.33	38.51	20.92	15.77	10.75	6.89
1977-78	172.23	40.28	21.46	16.32	11.1	7.87
1978-79	174.8	40.48	22.64	16.15	11.39	8.12
1979-80	169.59	39.42	22.17	16.67	10.58	8.13
1980-81	172.63	40.15	22.28	15.81	11.66	7.82
1981-82	176.75	40.71	22.14	16.6	11.78	8.06
1982-83	172.75	38.26	23.57	16.38	10.94	7.87
1983-84	179.56	41.24	24.67	16.43	11.83	7.72
1984-85	176.33	41.16	23.56	15.94	10.62	7.38
1985-86	178.46	41.14	23	16.1	10.65	7.53
1986-87	176.41	41.17	23.13	15.95	11.27	6.95
1987-88	170.74	38.81	23.06	16	8.71	6.46
1988-89	182.28	41.73	24.11	14.6	12.04	7.34
1989-90	182.27	42.17	23.5	14.84	10.9	7.69
1990-91	185.74	42.69	24.17	12.36	10.48	7.44
1991-92	182.24	42.65	23.26	13.04	10.03	7.66
1992-93	185.7	41.78	24.59	12.71	10.62	7.54
1993-94	186.58	42.54	25.15	11.51	9.55	7.32
1994-95	188.05	42.81	25.7	11.33	10.22	7.87
1995-96	187.47	42.84	25.01	11.43	9.32	9.04
1996-97	189.5	43.43	25.89	10.8	9.98	9.12
1997-98	189.99	43.45	26.7	9.79	9.89	8.87
1998-99	191.65	44.8	27.52	10.25	9.3	9.34
1999-00	188.4	45.16	27.49	9.86	8.9	8.71
2000-01	185.34	44.71	25.73	9.8	9.83	8.53
2001-02	188.01	44.9	26.34	9.3	9.53	9.13
2002-03	173.89	41.18	25.2	9.33	7.74	7.67
2003-04	189.66	42.59	26.59	9.09	10.61	7.6
2004-05	191.1	41.91	26.38	8.67	9.23	8.79
2005-06	192.74	43.66	26.48	8.47	9.58	8.68
2006-07	192.38	43.81	27.99	7.76	9.51	9.14
2007-08	195.22	43.91	28.04	7.53	9.57	9.41
2008-09	141.9	45.54	27.75	7.79	8.75	9.41

2009-10	139.17	41.92	28.46	7.38	8.9	10.13
2010-11	141.56	42.86	29.07	6.25	9.61	11.24
2011-12	140.98	44.01	29.86	6.21	8.78	12.18
2012-13	139.94	42.75	30	5.79	7.3	11.98
2013-14	141.43	44.14	30.47	6.16	7.81	11.96

Source: Agricultural Statistics at a Glance 2017 Reserve bank of India Bulletin
Note: Total Cropped area (in million Hectares); Crops (in million hectares)

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