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Master of science

in

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Effect Of Covid -19 On Agriculture and Food Security (India)

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COVID -19 created havoc on all the sectors as well as people's life With the help of this thesis, we tried to investigate how covid – 19 created an impact on Indian agriculture and food security. We performed a series of different analyses on the factors on which India's food security is dependent.

From this thesis we found that on the national level there was no major change in the supply of food grain in India, prices were kept in check and there was no shortage of food availability . The agricultural Yield was the highest in 2020 in comparison with last 5 years. We found that the changes in agriculture in the area were different in a different state. We performed a detailed analysis of the district-wise land use and compared it with previous years' data from which we're able to find that there was no correlation between change in the agriculture area of a district and production and the number of COVID cases.

Nationwide lockdowns were put in place to contain the further spread of the virus. To study the impact of the lockdown on agriculture we study the seasonal (Kharif and Rabi)wise production of food grain in the district of India. Later this data was compared with the migration of labor movement. We performed a separate analysis to track the reverse migration of agriculture labor, their home state, and their working district. We were able to establish a trend in the state from where the migration of labor happened in those states there was a decline in production whereas in the home state of labor there was a slight increase in production found that in the state of Punjab, Haryana there was a steep decline in the Kharif production whereas in the state of Uttar Pradesh and Bihar there was a slight rise in the production. Apart from major food grains, crops such as sugarcane, potatoes, and other crops, faced a reduction in the area of cultivation (district).

In the later part of the thesis, we calculated the water scarcity among the districts of India in terms of the number of months for the years 2017,2018 and 2020 .later the average number of the month a state is facing water scarcity was calculated.Changes in diets and consumption of food grains were calculated state-wise, we found that almost every state showed an increase in consumption of rice, wheat, and pulses how ever there was reduced consumption of cooking oil.

From the correlation analysis, we were able to establish a strong relationship between labor migration and the change in the area, production, and water scarcity. We Strongly recommend the Government establish a mechanism to reduce the dependency on migrated labor in agriculture. We also suggest promoting modern farming methods in the state of Uttar Pradesh and Bihar from where the highest outward migration and reverse migration was recorded.

Il COVID -19 ha creato scompiglio in tutti i settori e nella vita delle persone. Con l'aiuto di questa tesi, abbiamo cercato di indagare su come il covid-19 abbia creato un impatto sull'agricoltura indiana e sulla sicurezza alimentare. Abbiamo eseguito una serie di analisi diverse sui fattori da cui dipende la sicurezza alimentare dell'India.

Da questa tesi abbiamo scoperto che a livello nazionale non c'era nessun cambiamento importante nell'offerta di grano alimentare in India, i prezzi erano tenuti sotto controllo e non c'era carenza di disponibilità di cibo. La resa agricola è stata la più alta nel 2020 rispetto agli ultimi 5 anni. Abbiamo scoperto che i cambiamenti nell'agricoltura nell'area erano diversi in stati diversi. Abbiamo eseguito un'analisi dettagliata dell'uso del suolo a livello distrettuale e l'abbiamo confrontata con i dati degli anni precedenti da cui siamo in grado di rilevare che non c'era correlazione tra variazione dell'area agricola di un distretto e produzione e numero di casi COVID .

Sono stati messi in atto blocchi a livello nazionale per contenere l'ulteriore risparmio del virus. Per studiare l'impatto del lockdown sull'agricoltura, studiamo la saggia produzione di grano nel distretto dell'India (Kharif e Rabi). Successivamente questi dati sono stati confrontati con la migrazione del movimento di lavoro. Abbiamo eseguito un'analisi separata per tenere traccia della migrazione inversa del lavoro agricolo, del loro stato di origine e del loro distretto di lavoro. Siamo stati in grado di stabilire una tendenza nello stato da cui è avvenuta la migrazione di manodopera in quegli stati c'è stato un calo della produzione mentre nello stato di origine del lavoro c'è stato un leggero aumento della produzione. Ha rilevato che nello stato del Punjab, Haryana c'è stato un forte calo della produzione Kharif mentre nello stato di Uttar Pradesh e Bihar c'è stato un leggero aumento della produzione. Oltre ai principali cereali alimentari, colture come canna da zucchero, patate e altre colture hanno subito una riduzione dell'area di coltivazione (distretto).

Nella parte successiva della tesi, abbiamo calcolato la scarsità d'acqua tra i distretti dell'India in termini di numero di mesi per gli anni 2017, 2018 e 2020. Alla fine è stato calcolato il numero medio dei mesi in cui uno stato sta affrontando la scarsità d'acqua. I cambiamenti nelle diete e nel consumo di cereali alimentari sono stati calcolati in base allo stato, abbiamo scoperto che quasi tutti gli stati mostravano un aumento del consumo di riso, grano e legumi, nonostante fosse ridotto il consumo di olio da cucina.

Dall'analisi di correlazione si è potuto stabilire una forte relazione tra migrazione di manodopera e cambiamento del territorio, produzione e scarsità d'acqua. Raccomandiamo vivamente al governo di istituire un meccanismo per ridurre la dipendenza dalla manodopera migrata in agricoltura. Sugeriamo inoltre di promuovere metodi di coltivazione moderni nello stato dell'Uttar Pradesh e del Bihar, da dove è stata registrata la più alta migrazione in uscita e la migrazione inversa.

Earth has faced many pandemics in past such as Black plague ,Measles, cholera, dengue, smallpox and now the COVID-19 .It is said that in medieval and ancient age Pandemics were tread as wrath of God and the sick people were kept isolated from the rest of the worlds. The first reference of the word quarantine can be in found in the 14th century documents of Venice (Italy) when a ship was not allowed to dock for 40 days .Following this incidence the technique of quarantine was very prominently used in the other part of the worlds such as during chloral outbreak of 19th centaury .

First Case of Covid-19 was recorded in Wuhan China (Huang et al., 2020) in the late 2019 and on 11th March 2020 WHO officially declared COVID -19 as a global Pandemic(WHO Director-General's Opening Remarks at the Media Briefing on COVID-19 - 11 March 2020, n.d.) .India witnessed its first case of COVID-19 on 27th January 2020,in the southern state of Kerala, when a young engineer who came back from China on 27thof January got admitted into a local hospital with complain of dry cough and sore throat .(Andrews et al., 2020).On 14thof march 100th case of Covid-19 was recorded (Coronavirus (COVID-19) Cases - Statistics and Research - Our World in Data, n.d.)

During Feb and March India witness slow but study rise in the registered cases of COVID -19 ,due to which various measure were placed such as mandatory quarantine for the traveller coming from affected counties , however these measures were not sufficient to reduce the rising rate of spared (COVID-19: A Comprehensive Timeline of Coronavirus Pandemic in India | India News, n.d.).Therefore after realizing the gravity of the situation, Central Government of India placed the first nation-wide lockdown on 24th march, with the initial duration of 21 days (What Is Janata Curfew: Self Isolation by the People, for the People to Prevent Coronavirus | India News - Times of India, n.d.) First extension of lockdown was implemented on 14th April and later extended four times on 1st May ,17th May , 31 May and 30th June by the National Disaster Management Authority(Home | NDMA, GoI, n.d.).

The lockdown was the first time in India every modes of transportation were halted and only emergency service personals were allowed to move. These measures negatively impacted on socioeconomic well-being of people (Ghosh et al., 2020). GDP growth rate which is one of the major widely used indicator to measure the economic growth -7.5% in 2020 for India ,apart from Agriculture both industry and service sector showed a negative growth (Economic Survey, n.d.). Along with it the share of Agriculture and allied sector also increased to 20% in year 2020-21 from 18% in 2019-20.On the other hand year to year retail Food price inflation remain on 4% (Reserve Bank of India - Publications, n.d.).From economic point of view it seems like the agriculture sector didn't took much hit as the other sector did during pandemic in 2020. However agriculture is a diverse sector ,hence it becomes important to study the effect of COVID-19 at ground level of

Agriculture and to see whether the growth rate which was visible on paper is transferred on ground level or not .

For the purpose of In-depth analysis we conducted these analysis at national , state and district level. The structure of this Thesis is made in such a way that it can give readers a clear picture what was the analysis ,its methodology and result obtain from each study .This is divided in 5 chapter ,first is the introduction where we explain the development of agriculture in Indian , various programs and schemes launched by the government of India for the development of agriculture ,and the two market system of India and how it works .The later chapters 2,3,4,5 is dedicated to each analysis and there results . In the Final Chapter we tried corelate these analysis to obtain a conclusion and in the last part suggestion and way forward is given .

History of Indian Agriculture

According to the Merriam – Webster dictionary Agriculture is the art and science, of cultivating the soil, producing crops, and raising livestock and in varying degrees the preparation and marketing of the resulting products. Since the biggening of human civilization Agriculture has been a an important corner stone life. The roots of Indian agriculture can be traced back to pre-Neolithic time, playing a major role in the economy. It was considered as an honorable profession and principal means of livelihood. The earliest evidence as regards to agriculture comes from Mehrgarh (8000 BCE onward) in the Northwest and from sites in the Deccan, central India, Kashmir and the northwest Another. major evidence of the extent of the agriculture can be seen from the accounts of the *Megasthenes* which states that during the Mauryan era (3rd century BC) the greater part of the soil of India was under irrigation and consequently bore two crops in the year. The second major change was experienced by Indian agriculture system was during colonial era when, the East India Company introduced improved ploughs made upon Iron to replace wood. And the replacement of mortar and pestle mill for sugarcane crushing instead of wooden or stone roller mills. They also introduced waterpower for various purposes which were an important technological innovation in India. But during this era Only few Indian commercial crops such as Cotton, indigo, opium, and rice made it to the global market .

Indian Agricultural Developments

(1943–1964)

During the final decades of the colonial power in India, the country suffered with severe recurring famine. According to the various reports, since 1850, nearly 20 million people died due to famine in India (including present Bangladesh and Pakistan). Apart from environmental causes the commercial interest of the British Government was a major reason due to which nation had to face

acute food shortage. As during this period as the British Government were interested in growing only the cash crops like cotton, indigo, jute etc. in order to supply the raw material for their factories back in England. The last famine which was world's worst food disaster recorded during the colonial India happened during 1942–1943 known as the Bengal Famine. During World War 2 Burma was caught by Japan and the rice imports from Burma were hoarded by the British government resulting in exorbitant price rise. People could not afford to buy rice as the price of rice increased 3 to 4-fold [7]. Further, rice crop was badly affected by *Helmenthosporiumoryzae* and the productivity was suppressed considerably. Due to the collective result of these factor nearly 2 million people died as the result of Hunger induced by the famine

Therefore, food security and improving the agriculture was a dominant item of independent India's agenda as it has undergone unforgettable agony due to severe famines. The first five-year plan, (1950–51) heavy emphasis was given on the agricultural development along with irrigation, fisheries, animal husbandry and marketing. By the end of the first five-year plan Food production increased substantially from 54 MT to 65.8 MT.

1964- 2000

In 1965, India faced a widespread drought, due to which country had relay on the food aid program of USA popularly known as PL-480, but unexpectedly, the United States made the decision of not to export wheat to India. This decision led to the modernization of Indian agriculture system and to move beyond the goal of self-sufficiency. The program green revolution was launched under which large number of fertilizer plants were established during this, hybrid seed of rice, wheat was introduced and further, agricultural research and education were given attention. The result of this effort was visible as the country's food production capacity increased substantially to 108.46 MT in 1970-71, to 129.6MT in 1982–81, to 176.4 MT in 1990–91.

POST GREEN REVOLUTION

The regions (northwestern India) that showed tremendous growth in term of economics are now facing major ecological challenges of land degradation, yield plateauing, water logging and finally deceleration in compound growth rate. Currently Indian agriculture system is facing a period of stagnation in term of growth. If we Consider the period 1980–1990, the yield of food grains was increasing at 3.2% per year later in the next decade i.e., 1990–2000, the growth has slowed down to 2.9%, between 2000 and 2010, the food grain production has increased only by 1.2%, whereas in last decade 2010- 2020 this rate was only .7%

State wise Percentage of Population Registered in Public Distribution System (food)

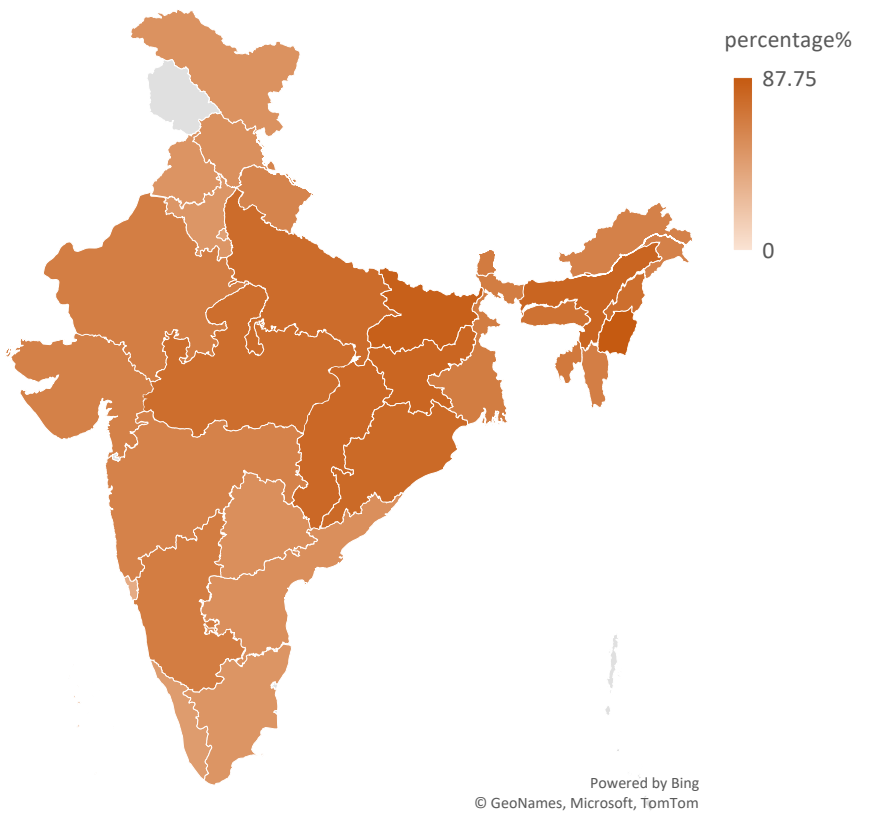
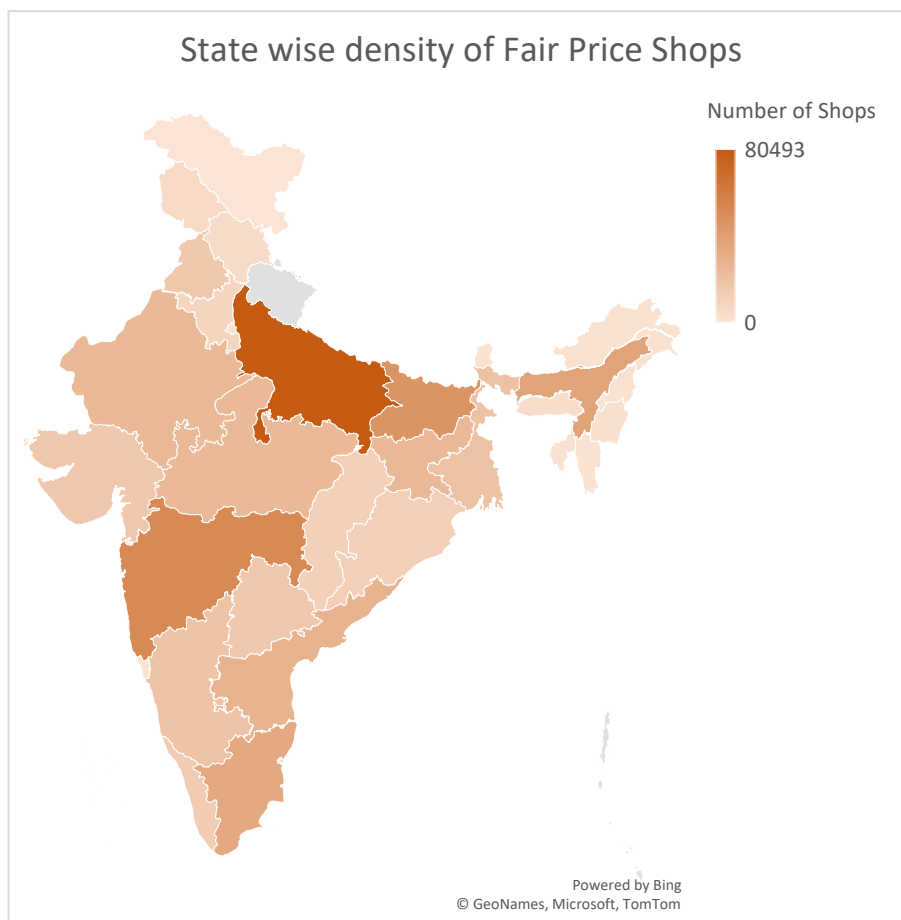
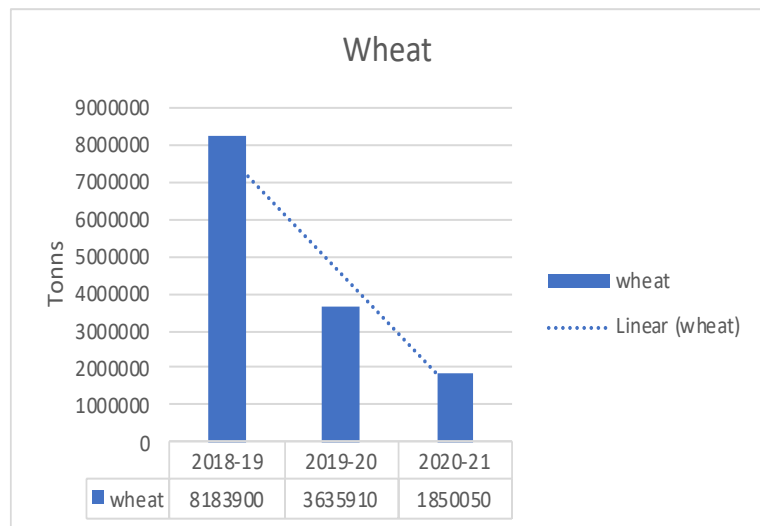
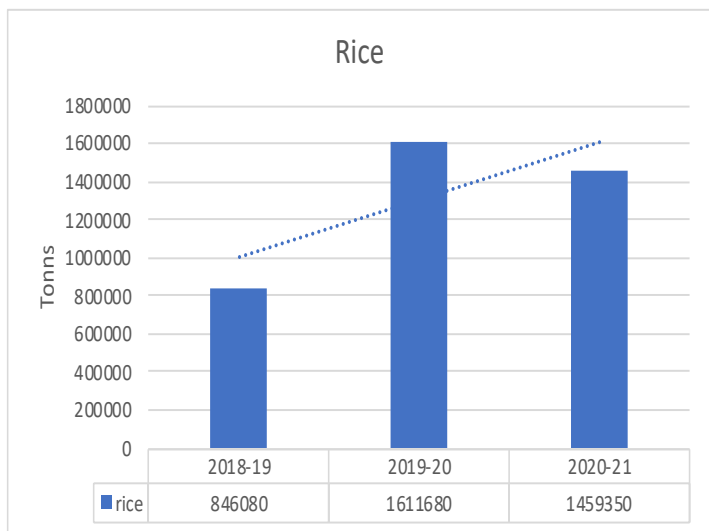


Figure i State wise Public Distribution System shops

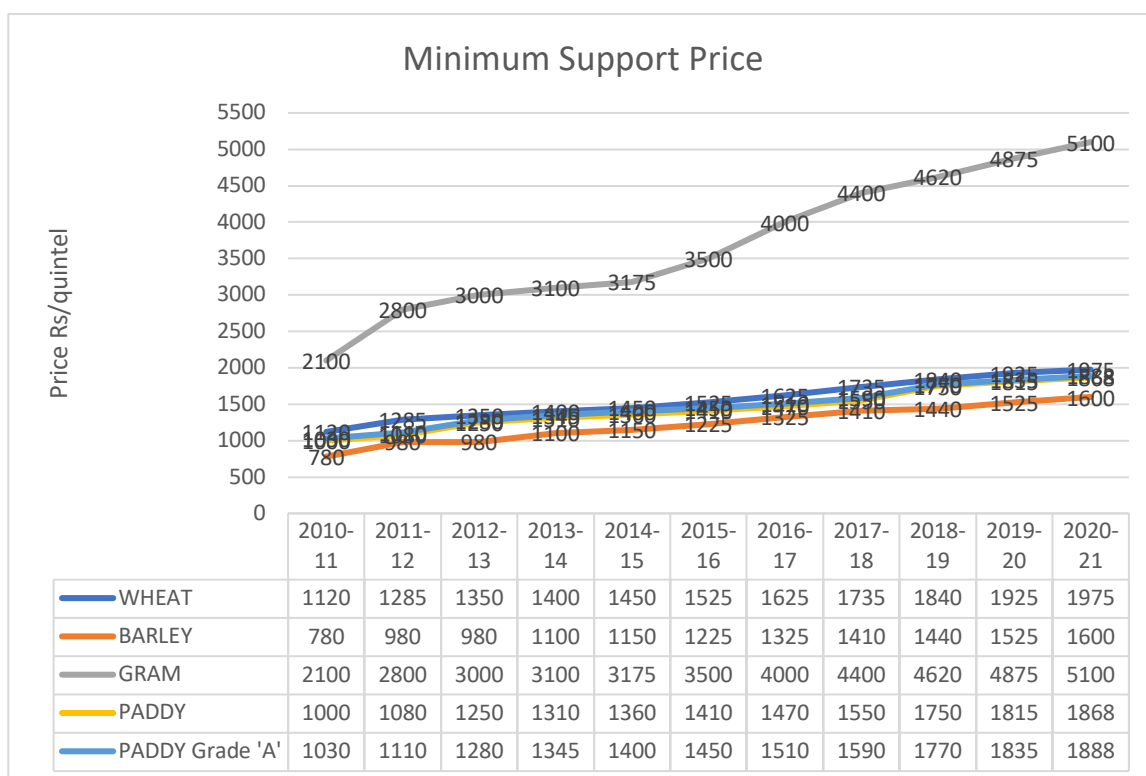
State wise density of Fair Price Shops



Agriculture is a state subject which means there is freedom to each state to make their own laws related to agriculture, and in case any law made by central government it has to be approved by at least more than half of the total number of states in country. The market of agriculture commodity in India does not follow a single streamline model but it is a dual market system under which the buyer is the government and in other the buyer is private entity. It can be a company, domestic trader or even an international buyer. The most important aspect of this market system is that the farmer is free to sell its produce in either of the two markets. First one in which government is the buyer, it covers 23 different types of agriculture commodity, and this varies according to state to state. MSP- Minimum Support Price (MSP) is the assured price at which food grains are procured from farmers by the central and state governments and their agencies. The central pool is used for providing food grains under the Public Distribution System and other welfare schemes. This food is later distributed to the registered beneficiaries through the network of fair price shops. Some portion is kept



as reserve in the form of buffer stock. In last five year government has resold the excess procurement in the open market .



Why MSP → On the path of the Green Revolution, Indian policymakers realised that the farmers needed incentives to grow food crops. In absence of these incentives and supports farmers will not grow wheat and paddy as they were labour-intensive and didn't fetch lucrative prices. Hence, to incentivise

the farmers and boost production, the MSP was introduced in the 1960s. The central government notifies MSP for 23 crops every year before the kharif (June to September) and Rabi (October to Feb, march and may) seasons based on the recommendations of the Commission for Agricultural Costs and Prices, under Ministry of Agriculture and Farmers' Welfare. These crops include food-grains such as cereals, coarse grains, and pulses, along with Rice, wheat. But public procurement is largely limited to a few food grains such as paddy (rice), wheat, and, pulses. The major reason is since rice and wheat are the primary food-grains distributed under PDS and stored for food security, due to which their procurement level is considerably high.

Year	PROCUREMENT cost (Rs./Qtl.)		DISTRIBUTION COST (Rs./Qtl.)		ECONOMIC COST(Rs./Qtl.)	
	Rice	Wheat	Rice	Wheat	Rice	Wheat
2016-17	597.21	367.26	432.59	362.23	3104.96	2196.98
2017-18	306.61	141.47	507.73	406.11	3280.31	2297.92
2018-19 (Unaudited)	450.40	280.86	550.42	402.85	3444.10	2359.73
2019-20 (Unaudited)	467.65	285.58	696.64	551.78	3720.06	2623.08
2020-21(RE)	466.07	300.51	836.31	573.77	3999.41	2739.62
2021-22(BE)	484.85	319.84	1018.94	753.18	4293.79	2993.80

Table i Last 5 years economic analysis of Welfare schemes

The procurement of food-grains is higher, in few states . For wheat Three states (Madhya Pradesh, Punjab, and Haryana) producing 46% of the wheat in the country account for 85% of its procurement(fig . Similarly For rice, six states (Punjab, Telangana, Andhra Pradesh, Chhattisgarh, Odisha, and Haryana) with 40% of the production have 74% share

in procurement.

Though the private market is free from the direct influence of the government and there prices are not controlled by any government entity . However in recent years the policy of MSP showed a significant effect on private agriculture. On example such interference was in October 2020, when the state of Punjab passed a Bill to prohibit purchase of paddy and wheat below MSP, due to which prices of wheat and rice got a lower threshold in the wholesale market .

In our study we found that 72% of the wheat and 92% of the rice produced in Punjab was purchased under public procurement in 2019-20 by the Government (state + centre). These kind of steps can lead to a disruption in the agriculture supply chain and shortage of food in the private market .A Similarly, in November 2020, Rajasthan passed a bill to declare those contract farming agreements as invalid where the purchase is done below MSP , for all the notified crop .

Formulation for calculation of MSP -before every cropping session government announces minimum support price for selected crops . This prices are calculated on the basis of three variables are:

A2: It includes out-of-pocket expenses which a farmer has to bare. These expenses includes loans for fertilisers, fuel, machinery, irrigation, etc. and cost of leasing land.

A2+FL: It consist of the estimated wages of the labour which are used harvesting crops . It also includes contribution of family members and others. It is in addition to paid-out cost.

C2: It is known as Comprehensive Cost . It is the actual cost of production as it takes into account for rent and interest foregone on the land and machinery owned by farmers. It is in addition to the A2+FL rate.

As the Prices of all the three variables increases every year , as so the MSP for the selected crop

STATES 2019-20	Amount (in thousand ton)	State 2020-21	Amount
Ex-Punjab	7233	Ex-Punjab	9376
Ex-Haryana	2584	Ex.Haryana	3545
Ex-Karnataka	41	Ex-Karnataka	23
Ex-Uttra Pradesh	309	Ex.Madhya Pradesh	20
Ex.Madhya Pradesh	55	Ex-Andhra Pradesh	607
Ex-Andhra Pradesh	2030	Ex-Chhattisgarh	1588
Ex-Chhattisgarh	1542	Ex-Odisha	888
Ex-Odisha	1811	Ex-Telangana	3253
Ex-Telangana	2731	Ex-Uttarakhand	106
Ex-Uttarakhand	304		

Table ii Rice Sold to the government (state wise)

FROM STATES 2019-20	amount	FROM STATES 2020-21	amount
Ex.Punjab	8741	Ex-Punjab	8741
Ex-Haryana	5219	Ex.Haryana	3210
Ex-Karnataka	5	Ex-Karnataka	3
Ex-Uttra Pradesh	93	Ex-RAJASTHAN	58
Ex.Madhya Pradesh	1577	Ex.Madhya Pradesh	2784

Table iii Wheat sold to the government

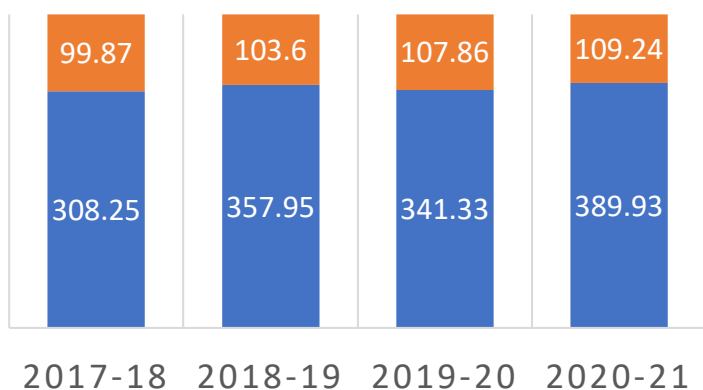
districts and towns within the states. These markets geographically divide the state. Licenses are issued to the traders to operate within a market. The mall owners, wholesale traders, retail traders are not given permission to purchase the produce from the farmers directly, as they are not allowed to register ,but they can buy the harvest outside the market system or by contract farming.

From where Government Buys(states)-As we saw In the above section that it is the farmer who decide wither to sell its harvest to government or not farmers .So it became very important to understand that framer form which state is selling to government in large quantity . In the table 1 and 2 we can see that the name of state and there share in Government stock for year 2019 and 2020 . We can see that Punjab is the hight Rice and Wheat supplier to the government .Similarly the state of Haryana and Madhya Pradesh and Uttar parades too. (Department of Food & Public Distribution, n.d.). Private market – Agricultural Produce Market Committees (APMC) is the marketing boards established by the state governments in order to eliminate the exploitation incidences of the farmers by the intermediaries, where they are forced to sell their produce at extremely low price. The harvest must be brought to the market and sales needs to be made through auction. The market place i.e., Mandi are constructed in all the

Government Procurement in 2020

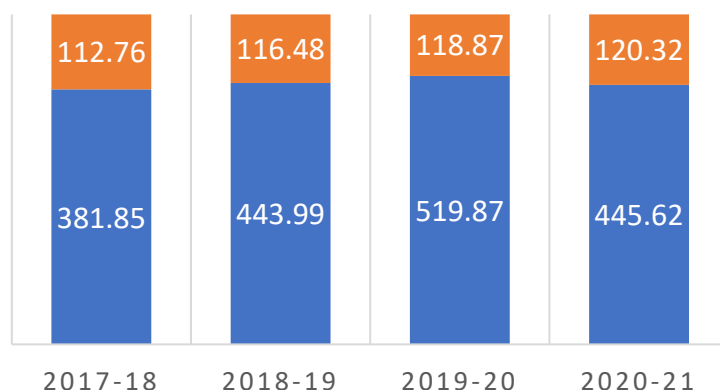
WHEAT

■ Production ■ Procrument



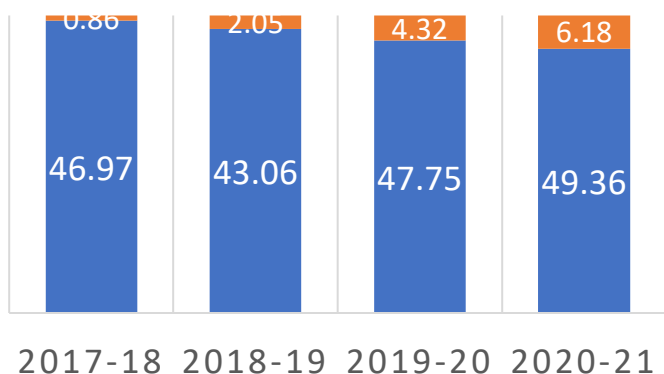
RICE

■ production ■ procrument



CORSE GRAIN

■ production ■ Procrument



From the data released by (Department of Food & Public Distribution, n.d.) we found that Procurement of the wheat and rice and coarse grain was higher than their respective previous year. In the major reasons can be attributed to this rise can be, , increase in the MSP, better transportation, stability of government market and vulnerability of private market. etc

Production of food grains

Figure ii Production and procurement of Food grains

Food Distribution

In this Table we can see the food stock available by the government by end of each agriculture year. We can see that there was highest stock of food grain in year 2020. High stock directly means higher procurement by

government. We can assume that this was due to uncertainty of price especially during covid-19 and partial closure of agriculture

Year	Allocation & Offtake	PMGKAY		ANBP (Migrant)		Non-NFSA (Covid-19)		Total	
		Rice	Wheat	Rice	Wheat	Rice	Wheat	Rice	Wheat
2020-21	Allocation	214.08	106.97	5.56	2.44	7.09	2.57	226.73	111.99
	Offtake	195.99	103.10	4.58	1.83	7.09	2.57	207.66	107.50

Table iii Distribution of Food grains through various welfare scheme

Year	Rice	Wheat	Coarse Grain ⁱ
2017-18	381.85	308.25	0.86
2018-19	443.99	357.95	2.05
2019-20	519.97	341.33	4.32
2020-21	529.25	389.93	11.63

Table iv Year End food stock by the government

market in some states , there was the highest procurement was recorded for rice ,

wheat and cores grain which was 529.25×10^6 , 389.9×10^6 , 11.63×10^6 ton.

In above table 4 we can see that amount of food grain (offtake) by the consumers from shops , this number included the consumption data ,of registered benefactrices under each welfare program .

Conclusion

The two market system of India was designed in order to promote cultivation of wheat and rice ,aswell as to protect vulnerable farmers . However with the presence of MSP , there is over over cultivation of rice and wheat due to which other non MSP crops have been neglected. Intense cultivation of paddy in Punjab and Haryana has caused acute water scarcity and deterioration in soil health .

The National Food Security Act 2013 (also 'Right to Food Act') which aims to provide subsidized food grains to approximately two thirds of the country's 1.2 billion people. It included the pre-existing Public distribution scheme and mid-day meal scheme for school children. The additional feature of this scheme is .

- 75% of Rural and 50% of Urban population is entitled to receive highly subsidised food grains under two categories of beneficiaries – Antodaya Anna Yojana (AAY) households and Priority Households (PHH).

The Act entitles 35 kg of food grains per AAY Household per month, whereas 5 Kg of food grain per PHH Person per month.

- Identification of beneficiaries/households under NFSA is done by respective State/UT Government, which is required to frame its own criteria.
- Highly subsidised Central Issue Prices of Re.1, Rs.2 and Rs.3 for Coarse-grains, Wheat and Rice respectively.
- Eldest woman of the beneficiary household (18 years or above) is considered as 'Head of Family' for the purpose of issuing ration cards.
- Grievance redressal mechanism, through State Food Commissions, DGROs, Vigilance Committees at different levels are provisioned for Women Empowerment.
- Provisions for disclosure of records relating to PDS operations, placing of beneficiaries' list in public domain/portals, for enhanced transparency
- Assistance to States/UTs for meeting expenditure on intra-State transportation & handling of food-grains and FPS Dealers' margin
- Modernization of agriculture by providing hybrid seeds

Macro Management Mode of Agriculture- Initiative for agricultural development in India was started in year 1950 soon after independence . Despite of the concerted efforts, the sector remains weak in all fronts. The Macro Management of Agriculture Scheme is one of the centrally-sponsored schemes formulated with the objective to ensure that central assistance is spent on focused areas and specific interventions for the development of agriculture is made across the States in the country this scheme was launched in year 2000 and became operational from 2001 in all the States and Union Territories (UTs) by integrating the then existing 27 Centrally Sponsored

Schemes of agriculture and its related activities (Ministry of Agriculture, Govt. of India). part of the revised scheme was Distribution of hybrid/high yielding variety seeds, not older than ten year. The older varieties which are having higher yield may also be distributed. Emphasis would also be on production of seeds where involvement of private sector will be encouraged. the monetary support are divided on the basis of the crops

(i)Rice and Wheat	(i) Rs.500/- per quintal or 50% of the cost, whichever is less for certified seed distribution for rice and wheat, by government .
(ii)Bajra,	(ii) Rs.800/- per quintal or 50% of the cost, whichever is less for certified seed distribution of varieties for Bajra, Jowar and Barley
	(iii) Rs.1000/- per quintal for certified seed distribution of hybrid of Bajra and Jowar.
	(iv) Rs.1000/- quintal or 50% of the cost, whichever is less for assistance for production modified hybrid rice seed.
(iii)Jowar,	(v) Rs.2000/- per quintal or 50% of the cost, whichever is less assistance for production hybrid rice seed distribution.

Integrated Scheme on Oilseeds, Pulses, Oil Palm and Maize- Original scheme was launched under the name of Technology Mission on Oilseeds (TMO) was launched in 1986 with a view to increase the production and productivity of oilseeds to make the country self-reliant in this vital sector. Subsequently pulses, oil palm & maize were also brought into the ambit of the Technology Mission in 1990, 1992-93 & 1995-96, respectively. currently it is an umbrella scheme which include 4 sub schemes

Integrated Scheme on Oilseeds, Pulses, Oil Palm and Maize	All Oilseeds, Pulses and Maize	(i) Full cost for purchase of Breeder seed(100%remabursement). (ii) Rs.1000/- quintal for foundation and certified seed production.
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	Oil Palm Sprouts	(iii) Rs.1200/- per quintal or 25% of Seeds cost whichever is less for certified seed distribution. (iv) Full cost of Seed Minikits of high yielding varieties (implementing agency NSC/SFCI). (v) 75% of the cost with a ceiling of Rs.7500/ha.for entire land holding of farmers.
Hybrid Rice Seed Production	Only Rice	Hybrid Rice Seed Production assistance Rs.2000/qtls.

National Food Security mission (seed)→This is one of the 5 sub sectors of NFSA The Government of India through the National Development Council (NDC) has launched the National Food Security Mission (NFSM). The mission targeted to increase the production of food grain in the state. Also, this scheme facilitates in developing new high-yielding/hybrid varieties of field crops, horticultural crops and breeder seeds for promoting the sustainable agriculture in the nation.

National Food Security Mission(NFSM)seed village program	Rice	(i) Rs.1000/- per quintal or 50% of the cost whichever is less for certified hybrid rice seed production. (ii) Rs.2000/- per quintal or 50% of Seeds cost whichever is less for certified hybrid rice seed distribution. (iii) Rs.5/- per kg. or 50% of the cost, whichever is less for certified high yielding varieties seed distribution. (iv) Full cost of Seed Minikits of high yielding varieties.
	Wheat	(i) Rs.5/- per kg. or 50% of the cost whichever is less for certified high yielding varieties seed distribution (ii) Full cost of Seed Minikits of high yielding varieties.
	Pulses	(i) Rs.1000/- per quintal for foundation and certified seeds production. (ii) Rs.1200/- per quintal or 50% of the cost whichever is less for certified seed distribution.

		(iii) Full cost of Seed Minikits of high yielding varieties
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PMKSY(irrigation development program) - The aim is extending irrigation cover and improving water use efficiency ('Per Drop More Crop'). Under this programme, financial assistance of up to 55 per cent is available for small and marginal farmers and 45 per cent for other farmers for adoption of micro-irrigation systems. This Program aim to harness the untapped irrigation potential of the country . According to a report publish in fao (P.V. Dehadrai),the irrigation potential of the country is 139.5 mha. but currently India has acquired an irrigation potential of about 84.9 mha which is approx. 60% . therefore to increase this potential government is focusing on increase the gross irrigated area as well the irrigation output . That is why Micro irrigation is given special importance under umbrella scheme for promotion of better irrigation at pan India level.

Mission for Integrated Development of Horticulture (MIDH)- This an umbrella scheme for the holistic growth of the horticulture sector covering fruits, vegetables, root & tuber crops, mushrooms, spices, flowers, aromatic plants, coconut, cashew, cocoa and bamboo.

While Government of India (GOI) contributes 85% of total outlay for developmental programmes in all the states except the states in North East and Himalayas(100% in these states), 15% share is contributed by State . Under MIDH, financial assistance is provided for following major interventions/activities:

- Setting up of nurseries, tissue culture units for production of quality seed and planting material.
- Area expansion i.e. Establishment of new orchards and gardens for fruits, vegetables, and flowers. · Rejuvenation of unproductive, old, and senile orchards.
- Protected cultivation, i.e. poly-house, green-house, etc, to improve the productivity & grow off season high value vegetables and flowers.
- Organic farming and certification.
- Creation of water resources structures and watershed management.
- Bee-keeping for pollination.
- Horticulture Mechanization.

- Creation of Post-Harvest Management and Marketing infrastructure.

National Mission of Sustainable Agriculture (NMSA). Green revolution did not cover all the states and some used excessive chemicals due to which now they are suffering from land degradation . So promote organic and sustainable farming NMSA was formed .Under this program Organic farming is promoted through adoption of organic village by cluster approach and PGS certification. The Scheme envisages:-

- Promotion of commercial organic production through certified organic farming.
- The produce will be pesticide residue free and will contribute to improve the health of consumer.
- It will raise farmer's income and create potential market for traders.
- It will motivate the farmers for natural resource mobilization for input production.
- Groups of farmers would be motivated to take up organic farming.
- Fifty or more farmers will form a cluster having 50 acre land to take up the organic farming under the scheme. In this way during three years 10,000 clusters will be formed covering 5.0 lakh acre area under organic farming.
- There will be no liability on the farmers for expenditure on certification.
- Every farmer will be provided Rs. 20,000 per acre in three years for seed to harvesting of crops and to transport produce to the market.
- Organic farming will be promoted by using traditional resources and the organic products will be linked with the market.
- It will increase domestic production and certification of organic produce by involving farmers

Crop Diversification programs-

Crop Diversification Programme (CDP), it is a sub scheme of national agriculture development program (RKVY) is being implemented in Original Green Revolution States with the aim to divert the area of paddy crop to alternate crops and in tobacco growing states to encourage tobacco farmers to shift to alternate crops/cropping system. Under this program ,farmers are encourage for replacing paddy crop, assistance is provided for four major interventions viz., alternate crop demonstrations, farm mechanization & value addition, site-specific activities &contingency for awareness, training, monitoring, etc the state Include Punjab ,Haryana , and western Uttar Pradesh

TRFA- The TRFA scheme, funded under the National Food Security Mission (NFSM). The Government of India's initiative on building sustainable pulse production in rice fallows in these regions will have a positive impact on overall income and nutritional outcomes in the region. The surplus production generated by this initiative will also positively impact the rest of the country

Mechanization of fields – Under the National Food Security Act it promotes usage of farm machineries or implements in cultivation of target crops for improved production efficiency. Financial assistance to an extent of 50% of the cost of the implements is provided for selected list of 22 implements. Financial subsidy per unit along with the ceiling of assistance is provided in the. The data is given in the geo tagging Of NFSM

Sub-Mission on Agricultural Mechanization-

- The Sub-Mission on Agricultural Mechanization (SMAM) was launched in April 2014 with an aim to have inclusive growth of farm mechanization to boost productivity. In the year 2020-21, budget of Rs.1,033 crore has been provided for the scheme, out of which Rs.553 crore has been released to state governments. Under the scheme Individual farmers are also provided subsidy for procurement of machinery. Agricultural mechanization helps in increasing production through timely farm operations and cut in operations by ensuring better management of inputs. Mechanization also enhances the productivity of natural resources and reduces drudgery associated with various farm operations.

To study the effects of covid-19 on Indian population .It is necessary to understand the steps taken by the government during the first wave to support poor and marginalised people . We already seen that NFSA has a wide base of coverage in India covering 75% of the country's total population .Therefore we focused on the data related to registered beneficiary under Public distribution system (NFSA) along with the special assistance(additional) provided to farmers in order to support their harvest . To provide some economic relief to the marginalized people government gave an economic stimulus of 24 billion USD . various provisions of this package was-

- ₹1500 each to 19.86 crore women Jan Dhan account holders
- LPG cylinders to be provided to 8 crore poor families for the next three months free of cost.
- ₹1,000 for senior citizens to tide over difficulties during next three months

Apart from monetary support , the government provided additional support by distributing additional food grains to registered and non-registered (but living BPL) people . The large number of non-registered people are from on organised labour sector, these labour work on a daily wages basis mostly in capital cities .Most of these workers belongs to migratory worker class , they move from their home town to different cities and states in order to search of work . According to an

estimate by world economic forum India. has 139 Million migratory workers out of which a large number belong to BPL categories .To support them government allocated food grains under a special scheme as these most of these people were registered in their home town not at their town where they were working , the data for food distribution under this program is given in table 1.

In year 2019-20 and second half of 2020, total of 226.73×10^6 Ton rice and 111.99×10^6 tons of wheat was picked up /Procured (Department of Food & Public Distribution, n.d.) .Whereas for The registered persons under AAY , PHH and NFSA government were provided additional food allocation under each scheme . For them 10 kg of rice , wheat per member per month (5kg existing + 5 kg extra) along with 1 kg of pulses per family was allotted for the period of April to November free of cost . Where As For the Beneficiaries under the existing National food security act (Non away /Phh categories) food grain was increased by 2kg from 5 to 7 kg per person per month. However some states also provided advance 3 months food Grains along with the additional benefits to the people in order to avoid movement of public ((Department of Food & Public Distribution, n.d.)

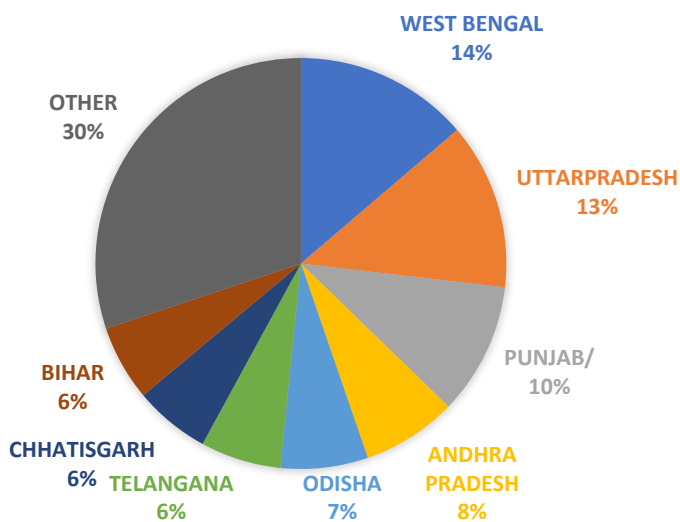
It is important to note that according to the data produced by Government of India in Indian parliament a total of 237 million people are registered under AAY Anthodia Ann yojana (AAY) and Priority households (PHH) .However Each state has specific criteria to identify these households. For AAY, the inclusion criteria include household without shelter, landless laborers, beggars, sweepers or sanitation workers, etc, this scheme targets to the poorest of the poor.

Benefits given to the Farming Sector

For the farmers the quarterly benefits of INR 2000 was given early, along with all the other cash transfer benefits . these other scheme are PM- JDY which promotes the financial inclusion of rural and marginalised population ,women benefiter of this scheme was given INR 1500 one time cash transfer , the total benefiter of this scheme was 204 million. The result of the these schemes as visible as the consumption of rice , wheat increased sharply in compare with the previous year data.

Major Agriculture States in India –

RICE PRODUCTION.



WHEAT PRODUCTION

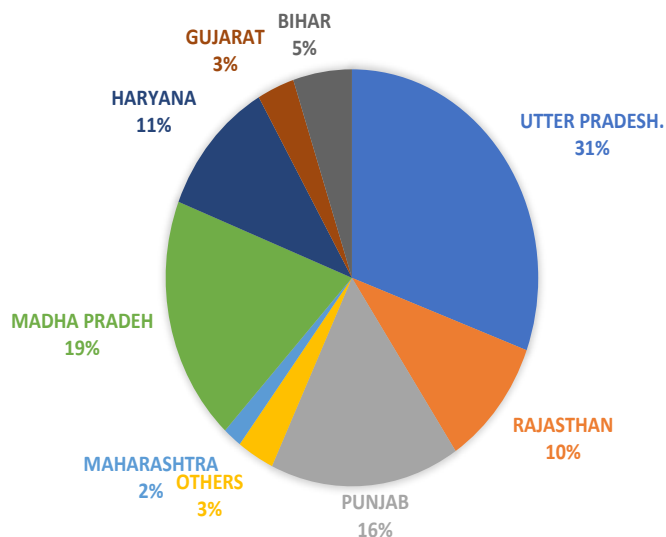


Figure iii Wheat and Rice Production State wise share

India's gross agriculture production comes from largely ten states which are leading producers in the most essential food grains. These states are –

West Bengal – It is the largest food grain producing state in India, especially known for its rice production along with that it is famous for jute, sesamum, tobacco, and tea too. In West Bengal, rice's total production is 146.05 lakh tons on 2600 kilograms per hectare yield. The state is well connected with connected with sea.

Uttar Pradesh – It is the largest state of India in terms of area, it is the top producer of sugarcane and wheat. It comes under the top wheat producing states in India. Uttar Pradesh has 22.5 million tons of wheat, and the weather condition is appropriate for growing wheat. On 96 lakh hectares, land used

to grow wheat in Uttar Pradesh. The state produces 145.39 million tons of sugarcane and grows on 2.17 million hectares in the state.

Punjab – It is also known as the bread basket of India. Due to its best to produce wheat, sugarcane, rice, vegetables, and fruits in Punjab. Punjab's other name is the Granary of India and India's breadbasket. Around 93% of the total productive land used to produce food grain. In Punjab, most of the area covered by wheat and paddy cultivation. And this area increases over the year. Punjab is the 3rd largest farming crop producing state in India. It is known for its irrigation system and these are appropriate for farming. Punjab is the 3rd largest producer of food grains too.

Gujarat – It is the fastest growing state in India. This state adopted a wise development pattern. They invested in agriculture, energy, and industry, for that they achieved a double digit growth.

Gujarat's weather climate is variable, producing crops there is difficult. One strategy farmers can adopt there is to manipulate crop environments by advanced management for high yield. Gujarat produced cotton, groundnut, castor, bajra, tur, green gram, sesamum, paddy, maize, and sugarcane. And Gujarat produced cotton in a large scale, followed by Karnataka, Maharashtra, and Telangana.

Haryana-It is one of the biggest contributors to agriculture. About 70% of the locals engaged in agriculture. Haryana plays an important role in the Green Revolution in India. With all these, Haryana has a massive irrigation system

Madhya Pradesh – It is known for its pulses production, followed by Maharashtra, Rajasthan, and Uttar Pradesh. It is popular for soybean and garlic production too. Madhya Pradesh earned significant fame in pulse farming.

Assam -it is the largest tea producing state in India. Assam's almost economy is based on agriculture, and 70% of the population is dependent on agriculture income for livelihood.

Andhra Pradesh-It has 62% of the population engaged in agriculture. There is more focus paid on rice production. Andhra Pradesh contributes 77% of crop production in India. And more crops are jowar, bajra, maize, ragi, tobacco, pulses, sugarcane, and others. This state is also a top producer in the horticulture products In 2018, from 1.5 million hectares of land used for horticulture. And from this allotted land nearly 720 thousand hectares used for fruit production.

Karnataka,- is the coffee farm of India with 70% of the country's total coffee production .. The weather climate of Karnataka greatly supports annually it grew 222300 metric tons of coffee.

Chhattisgarh - is popular for the Rice Bowl of Central India. Some of the crops that are produced in Chhattisgarh are rice, millets, and maize. In Chhattisgarh, 77% of the area used for rice production. Chhattisgarh is totally dependent on the rain. Only 20% of the total region is under irrigation.

“No society can surely be flourishing and happy, of which the far greater part of the members are poor and miserable”

-Adam Smith

The pandemic affected all four pillars of food security : Availability (is the supply of food adequate?), Access (can people obtain the food they need?), Utilization (do people have enough intake of nutrients?), and Stability (can people access food at all times?).

India faced a difficult choice between the need to contain the virus at cost of disastrous economic and food security crises that will hurt the nation’s poor and hungry most. Government announced the nation-wide lock down , this was the first time step of such nature was taken. Though no major food shortages is reported in India and even around the world .Food markets faced disruptions due to labour shortages created by restrictions on movements of people and shifts in food demand resulting from closures of restaurants and schools (Laborde et al., 2020).During this time large number of people lost their job most of them were daily wager and unorganised labour(Mishra, 2021) .A separate section is dedicated to them in the later part of the thesis

From the study the conducted in the previous section ,we saw that the amount of Food produced by the country in 2020 was highest in compare with last 5 years . Similarly there was a rise in production of all the major food crop India. Hence we can say that there was no shortage of food in India and exports were same . In the section we have performed analysis on the second pillar of the food security that is affordability , which means at what price food is available in the market .It import to know that if large amount food is available but the prices is very high then it is of no use.

In order to study the affordability of food in 2020 we calculated the monthly average prices(in private market) of five major food grains in all the states of Indian . The output of this analysis was then compared with the previous year data .Monthly price data was taken from(*Agriculture Marketing*, n.d.; *Farmer Portal : Home Page*, n.d.).It important to know that there are prices at which traders and large consumers buy from farmers .

Agriculture plays an important role in the Indian economy and strengthen the socio economic fabric of the country. In year 2020 India is a leading producer of fresh fruits, vegetables, milk, spices, pulses and several other food grains , second biggest producer of potatoes, rice and wheat (FAOSTAT, n.d.). Indian Farmers not only produce to supply in domestic market but also contributes heavily towards the exports. It is the seventh largest agricultural exporter and delivers processed food to more than 120 countries across the globe((*Agriculture In India: Agricultural Exports & Food Industry in India | IBEF, n.d.; FAOSTAT, n.d.*). Rice ,tea, sugar, oilseeds, tobacco ,spices are some of the major export commodities. Indian Basmati rice has special place in the culinary world. In term of market size , Gross Value Added by agriculture, forestry, and fishing was US\$ 276.37 billion in FY20 (*Economic Survey*,¹ n.d.). On the Other hand Share of agriculture and allied sectors in the GDP of India (at current prices) stood at 17.8 % in FY20.

In term of sector wise production of horticulture crops in India was estimated at a record 326.6 million metric tonnes (MMT) in 2020. India has the largest livestock population of around 535.78 million, which translates to around 31% of the world population. Milk production in the country is expected to increase to 208 MT in FY21 from 198 MT in FY20, registering a growth of 10% y-o-y. Area under horticulture is projected to rise by 2.7% in FY21.

According to Tripathi and Prasad, (2009), all sectors in India are significantly contingent on the agricultural sector and thus, constant improvement in this sector is important for the betterment of overall growth of the economy. Agriculture is a major supplier of raw materials for industry. Examples include cotton and jute for textiles, sugar and vegetable oil. Almost half of the total manufacturing sector is dependent on agriculture directly or indirectly. Therefore it became very important to study how agriculture as sector perform in India at national level.

Methodology

There are various sources available for the yearly statistics of Agriculture, however we have opted to take only the official data which is provided by Ministry of commerce, Ministry of statics and planning, Economic Survey of India FAO (*Economic Survey, n.d.; Home - Mcommerce, n.d.*)(*Government of India | Ministry of Statistics and Programme Implementation | MOSPI, n.d.*). Data of 2020 was compared with the previous years and a trend was tried to established. We have used MS Excel for the this section.

¹ Economic Survey of India is released every year in month of February before presenting annual budget

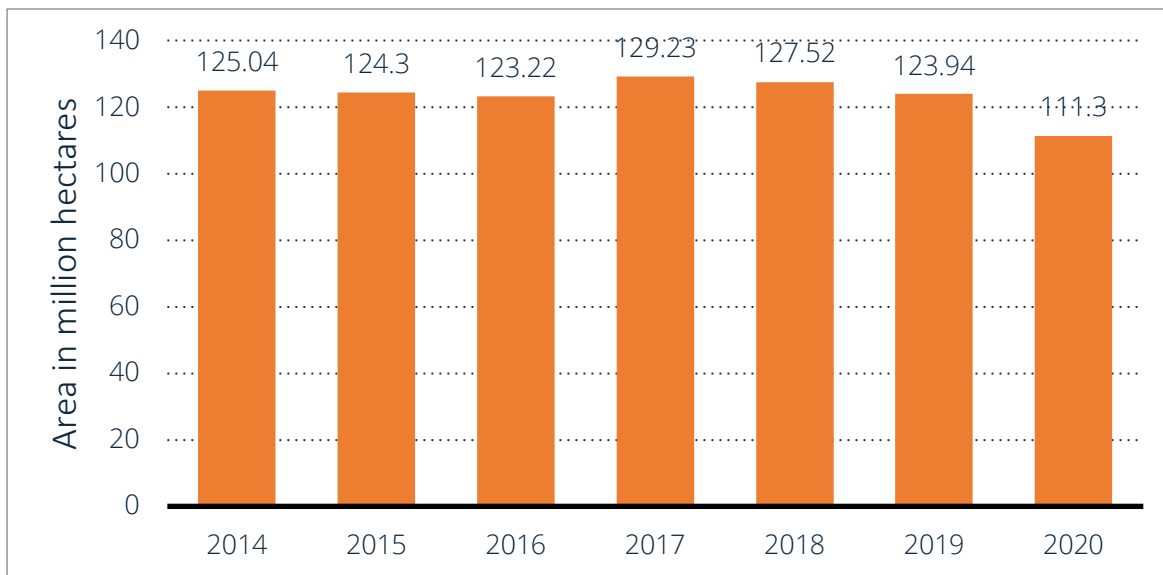


Figure iv Area under food grain cultivation

was a constant level of 120-129 million hectares . It was highest in the year 2017 with 129.23 Million hectares, since then we observed a steady decline and it reached its 5 year low at 111.3 million hectares.

Observation and Results –

Area and yield

In past 5 years average areas under food grain cultivation in India

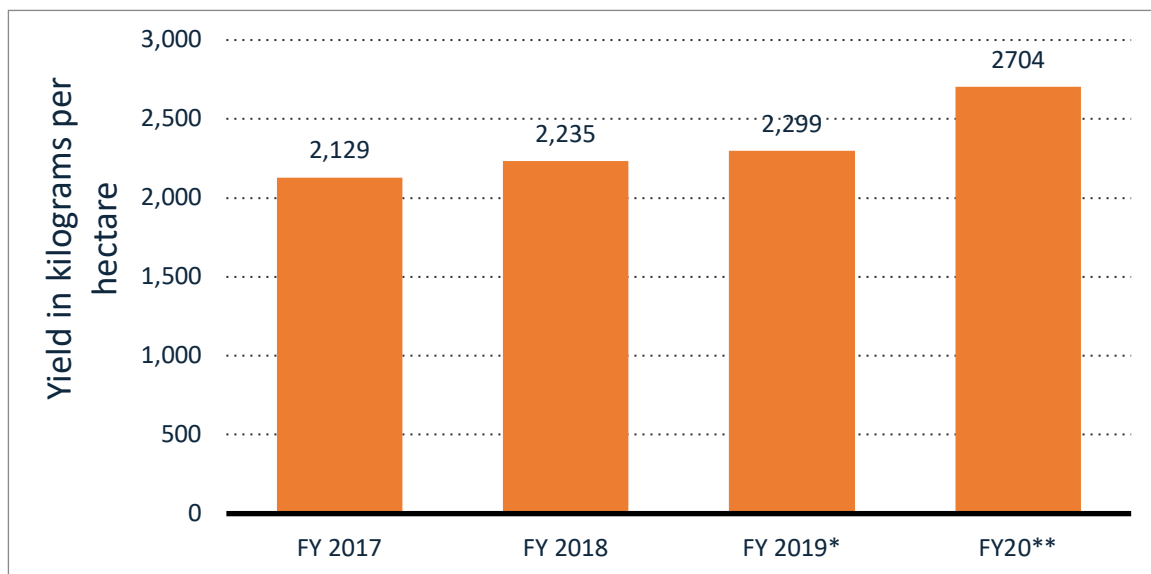


Figure v Yield of Food grains

When we studied that data regarding the yield of food grain (figure). It was noticed that the Yield went up from 2129 Kg /hectare to 2704 in year 2020 . highest in last 5 year.

In year 2020 approx. 10 million hectares of land was left uncultivated which used for farming in the previous year . But this reduction of area had no negative effect on the yield food grain and on contry it was highest , this can be due to better farming practice in selected areas.

Production of Food Crops Million Tonnes-2020

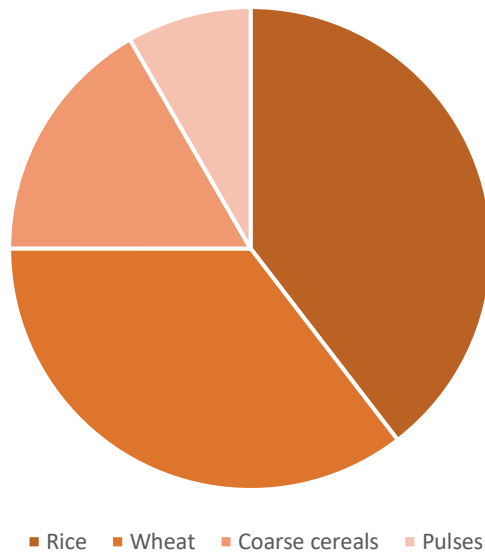


Figure vi Production share of Food crops

We calculated the production of five major food crop (Rice ,Pulses ,Wheat and Coarse cereals) in year 2020 and we found that it was 305 Million tonnes, in compare to 297 million tonnes in previous year.

Rice and Wheat is the major food commodity produced in India .

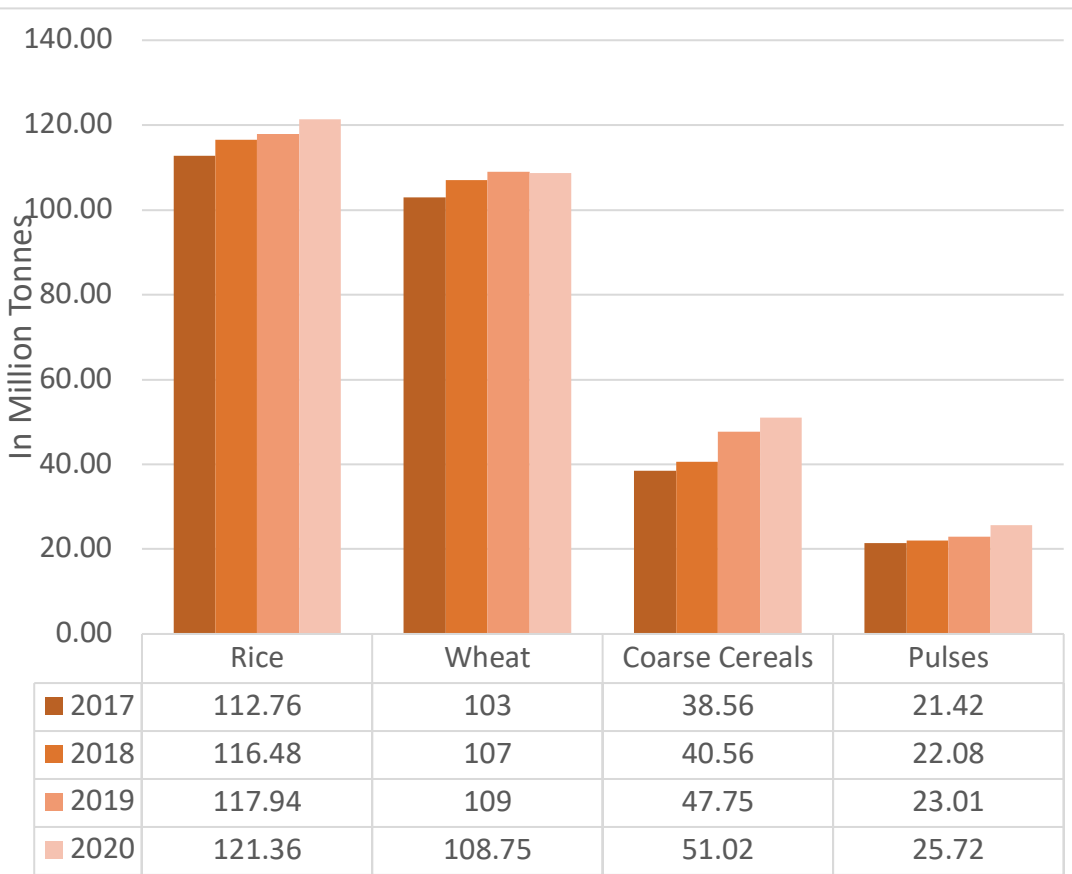


Figure vii last 5 year trend of Food grain production

The increase was uniform in all the four food crop when compared to the 2019 . In the figure we tried to show the trend of production of major food grain in India . Coarse cereals showed a 13 million tonnes of increase in the production in compare with the 2017 . Similarly there was 9 % rise in the production of wheat and Rice . Pulses product is on the major focus point of Government’s crop diversification program ,

though there was an increase in the pulses production however the rate of this increment was less the 5 % in last 4 year . This indicate that there is still a lot of scope in the diversifying program and better steps can be taken to increase this speed .

Agricultural Exports

India is among the 15 leading exporters of agricultural products in the world .In 2020 India exported was US\$ 35.00 billion worth of agriculture commodity (*Agriculture In India: Agricultural Exports & Food Industry in India | IBEF, n.d.*). Rice and milled products are the major contributor in this .

To know more about the agricultural export we studied the amount of food grains exported by India . It is important to note that there are not most exported agriculture commodity from India

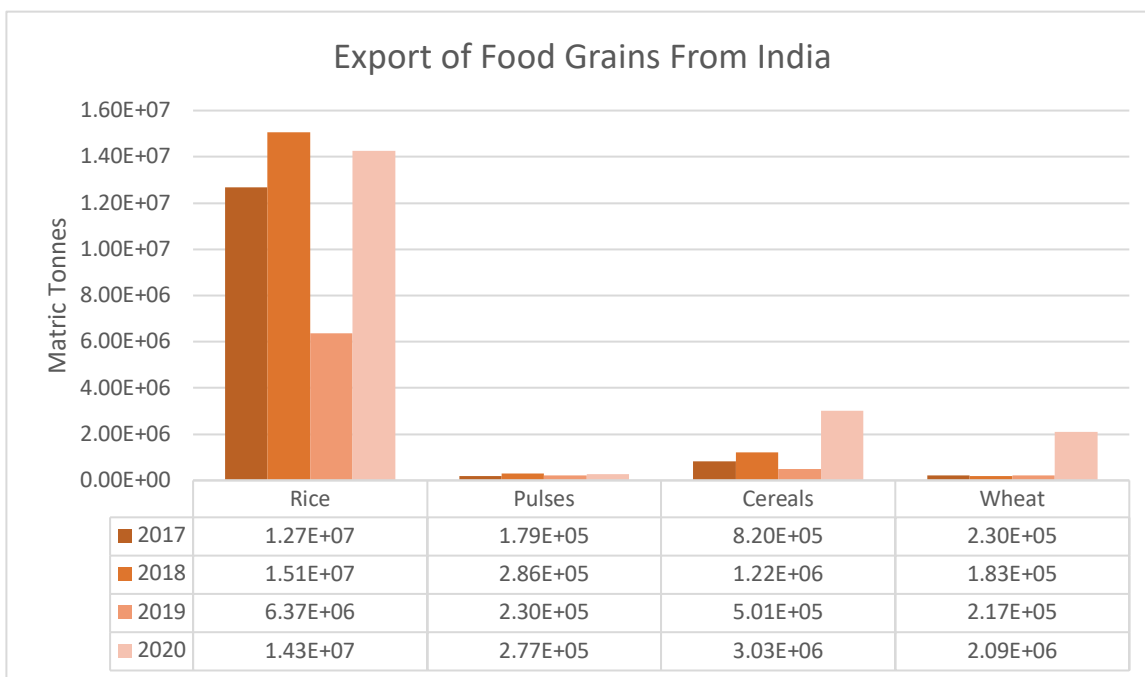


Figure viii Last 5 years Export of Food grains

however they makes a major portion of Indian diets and hence the linked to the domestic market . for example in 2018 government of India put a ban on pulse export in order to control the prices , any major disruption the supply chain can create a disruption the export quantity .After comparing the data

with the previous year , we found that there was jump in the export of pulses ,cereals ,and wheat .on the other hand export of rice was higher then 2019 but still it ws the the amount of Rice exported in 2018 . Pulses were least among the food grain item to get exported majorly due to better price and demand in the domestic market .In our analysis we have calculate amount of rice as both basmati and non-basmati.

Conclusion

With the help of this analyse we were able to find that the 2020 was successful year in term of exports and yield. India recorded highest production for its food grains and there was no major setback in export sector . However in terms of agriculture area , there as reduction bu it did not transferred to the yield and gross production .

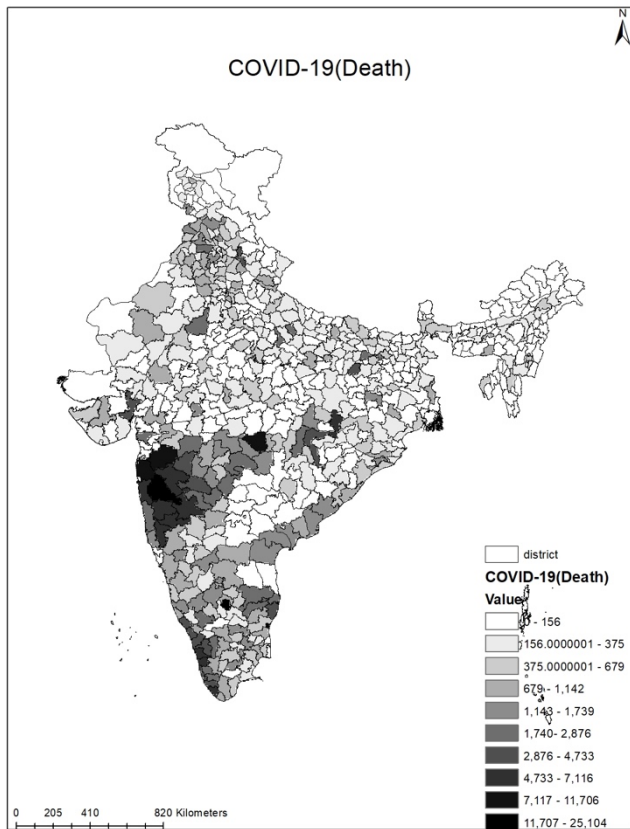
First 12 months of COVID -19 in India

According to the official records of WHO and Ministry of Health (India) , there are several recorded diseases outbreak in India. Some of them are cholera pandemic (1817–1899); the Bombay plague epidemic (1896), the influenza pandemic (1918), the polio epidemic (1970–1990), the smallpox epidemic (1974), the Surat plague epidemic (1994), the plague of northern India (2002), dengue epidemic (2003), the SARS epidemic (2003), meningococcal meningitis epidemic (2005), the Chikungunya outbreak (2006), the dengue outbreak (2006), the Gujarat jaundice epidemic (2009), the H1N1 flu pandemic (2009), the Odisha jaundice epidemic (2014), Indian swine flu (2015), Nipah (2018) (Chattu et al., 2018), and the ongoing COVID-19 (2020) pandemic, as well. The COVID-19's transmission is different from the previous outbreaks (Laborde et al., 2020). Hence it becomes important to see which regions of India recorded the highest number of cases as well as depth related to COVID-19. This analysis was done at the district level data. There are currently 755 districts in India (Home | DISTRICTS OF INDIA, n.d.). The size of these administrative units varies largely from the Kutch being the largest district of India with the area 45000 km² to Mahe being the smallest in terms of area of 8 km².

Methodology

This study was performed on districts. The data was taken from the press releases by the central health ministry and various state health ministry websites regarding New COVID-19 cases and Death related to COVID-19. The study period of this analysis was from 1st of February 2020 to 1st February 2021. Later on the basis of the data, district-wise colour scheme maps were prepared for cases and Death were prepared on Arc GIS and Excel.

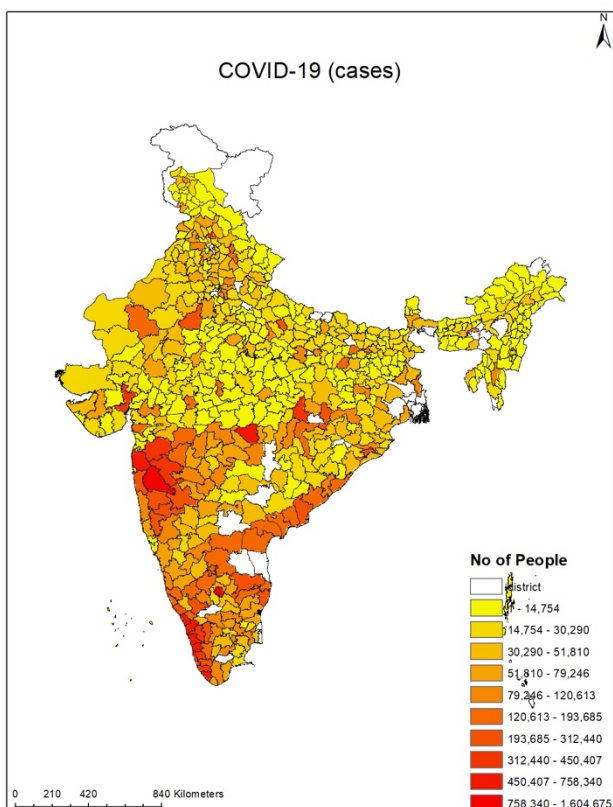
Observation and result



Highest Number of Registered cases were in the southern district of India name Bangalore , which the IT hub of India , followed by the national capital region of Delhi , Delhi is also the second most populous city in the world. We were Surprised to find that Mumbai which the second populous city in India and seventh in worlds was fourth in term of COVID-19 cases . If we look at the non metropolitan cites we found that district of Ernakulam, Kozhikode and Thiruvananthapuram were highest . On the other hand highest number of Death related to covid – 19 was recorded in. new Delhi , Pune and Mumbai . District of Nagpur was the worst effect district I n term of number of deaths in compare in non metropolitan city category .Almost all the districts of

North east region of India recorded very less cases and death compares to national average .One

region which we can assign to such trend is geographic isolation as well as less population density .However a more in-depth analysis is required .



When we study the state wise data we found that the in the state of Maharashtra all the districts reported cases and death higher then national average . State of Arunachal Pradesh recorded the least number of covid cases and death .

Figure ix COVID -19 cases and Death District wise

Migrant labour in India agriculture and

Human Migration is a significant aspect of social science and the oldest action against poverty. However, there has been a significant difference in the migration process of developed and developing countries((*Migrant Workers and Human Rights: A Critical Study on India's COVID-19 Lockdown Policy - ScienceDirect*, n.d.)According the Merriam Webster Dictionary Lockdown is a term which is used by the policy makers to completely stop the movement of people A lockdown is a restriction policy for people or community to stay where they are, usually due to specific risks to themselves or to others if they can move and interact freely. The term "stay-at-home" or "shelter-in-place" is often used for lockdowns that affect an area, rather than specific locations. The announcement of the lockdown triggered mass exodus and reverse migration of unskilled and semi-skilled laborers from major urban cities who walked back to their villages without food and money. Migration in India is different from the migration we see in developed countries . The reason is that migration in India is more influenced by push factors (perviousness, unemployment, regional disparities, family movement, marriage, natural calamities, etc) however, in developed nations are more pull factors like prosperity, safety, freedom, etc is the driving force (Lee, 1966).

Methodology

The study on the migration of labour during COVID-19 was done on the basis of data provided by government of India in parliament , Census 2011 and various News reports .It is important to know that no separate registry was prepared by the government on data base of occupation of migrated labour and the districts there were working .In Census 2011 , section B-3 ,B-11,B-12 was used to obtain number and occupation of migrant workers . Census identifies people as migrants if they are working in a place other than the Place of Birth or have changed their Usual Place of Residence to qualify for working. The duration of work should be more than 6months.The “place” can be a village or town/Urban Area. According to an estimation based on NSS done by (Ravi Srivastave, 2020),a total of 59 million short term circular migrant worker are present in India 14 million works in rural and 44 million works in urban . In rural 7.5 million works in agriculture which makes agriculture single largest sector for rural migrants , whereas in urban 25 million works in Construction sector .

Observation

First Figure , we can see that the highest density of agriculture migrant per thousand population are in the state of Haryana and uttrakhand, followed by Punjab and himachal Pradesh .The lowest density of Migrant workers are in the state of Bihar , Jammu and Kashmir and the northeast state of

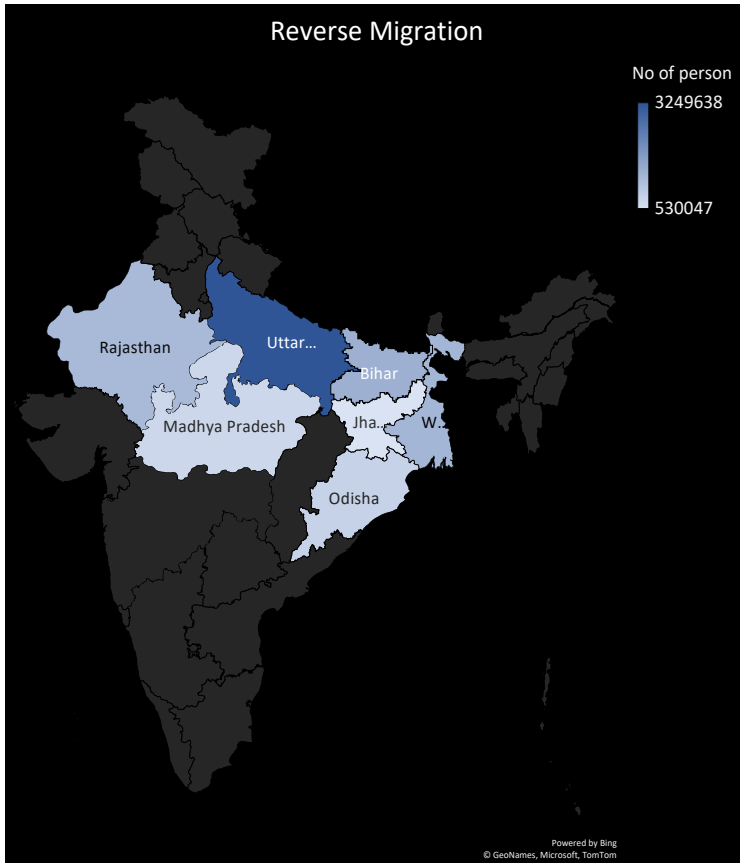
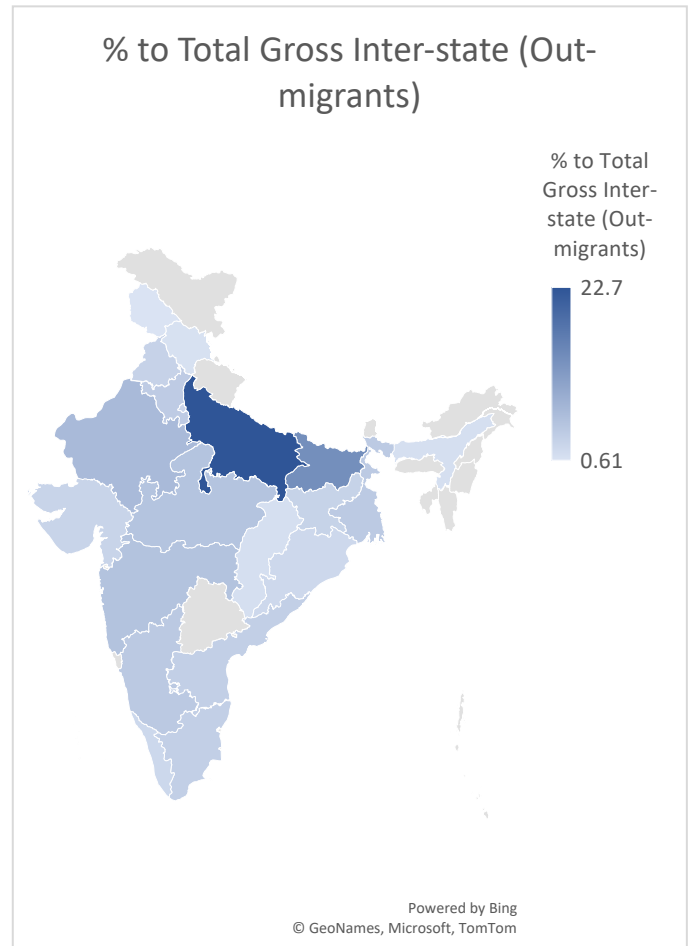
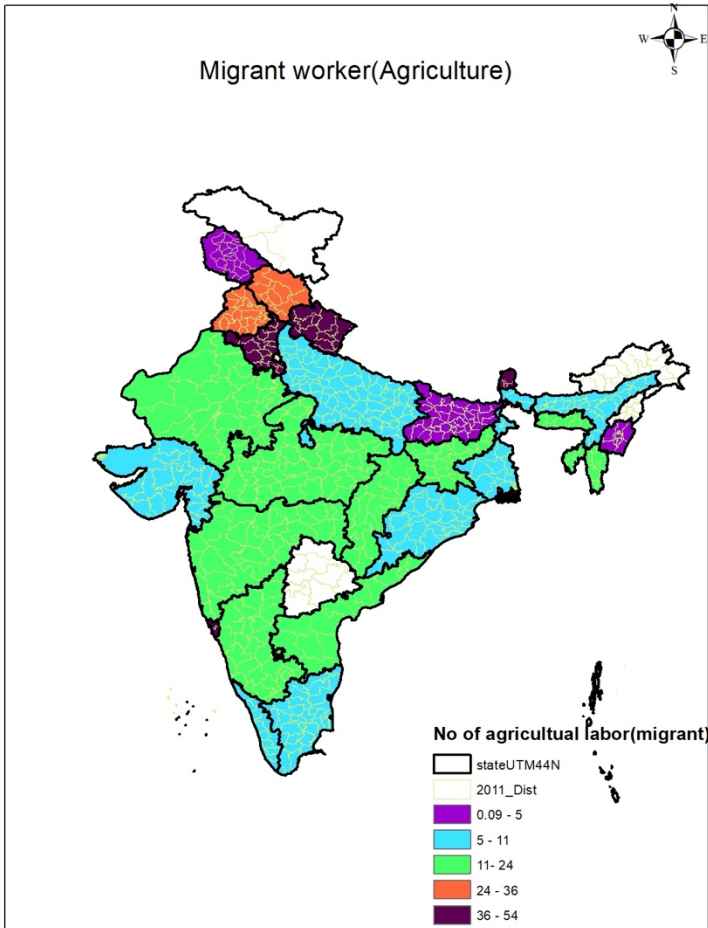


Figure x Trend Of Agriculture Labour Migration (before and during COVID-19)

Manipur . Almost half of the Indian districts have same density of 11 to 24 migrant per thousand population. The state of Gujarat, Uttar Pradesh, Kerala, Karnataka, Orissa and West Bengal, has low migrant labour (agriculture) density.

The second we calculated the share of state in outward agriculture labour migration. The state of Uttar Pradesh the largest state in India in terms of Population (census 2011), and it provides almost one fourth agriculture labour to the other state. It is followed by Bihar, Madhya Pradesh and Rajasthan. Himachal Pradesh and Jammu and Kashmir the lowest in terms of outward migration.

The third figure was prepared on the basis of data released by Ministry of Labour and Empowerment, approximately 10 million migrant workers return to the home state (March to June 2020).

(Over 1 Crore Migrant Labourers Returned to Home States on Foot during Mar-Jun: Govt

(/ *India News, The Indian Express*, n.d.) . We found that almost 5million migrants were from the state of Uttar Pradesh and Bihar .Rest of them were from Rajasthan , Odisha ,Jharkhand and west Bengal.

From the census were able to find that the largest number migrants belongs to construction sector they work as bricklayers , in quarried, masons and cleaners . Contractors give them a subsistence allowance and their full wages are only adjusted against advances at the end of their employment period(Ravi Srivastave, 2020).

Conclusion

Migrants especially of Construction and agricultural sectors ,enjoy a very weak relation with there residential villages They enjoy limited civic rights and entitlements in the areas where they work, due lack of proper papers and documents . These rights includes lack of access to the PDS and, in many cases, even to the banking system.(Ravi Srivastave, 2020).

Migrant workers are in the ocean of informality ,We can get an idea about this from the fact that till march 2020 there was no proper and updated official estimates about how many migrnats are actually going to get effected from the lockdown . Only data which was available was from 2011 census .

Farmer census at glance

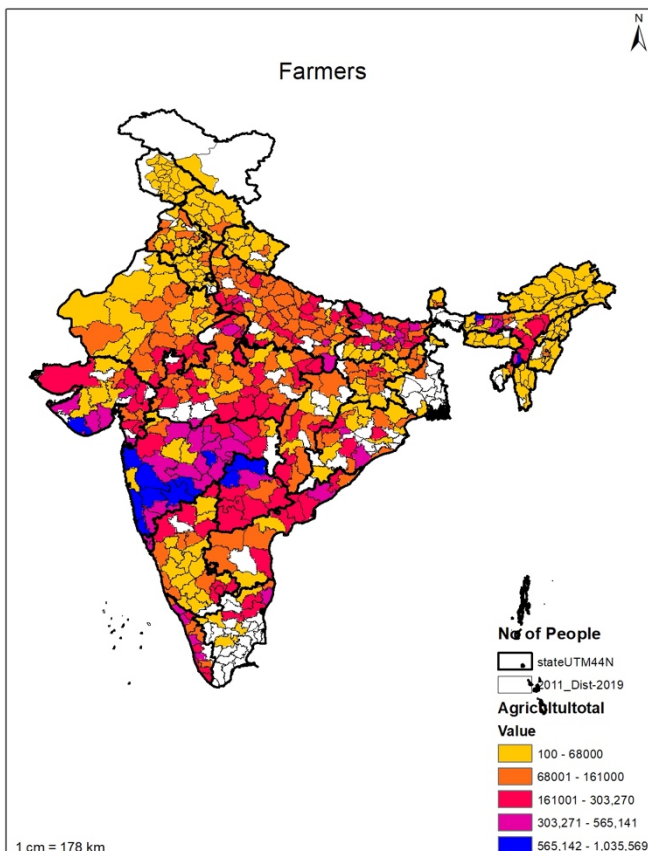
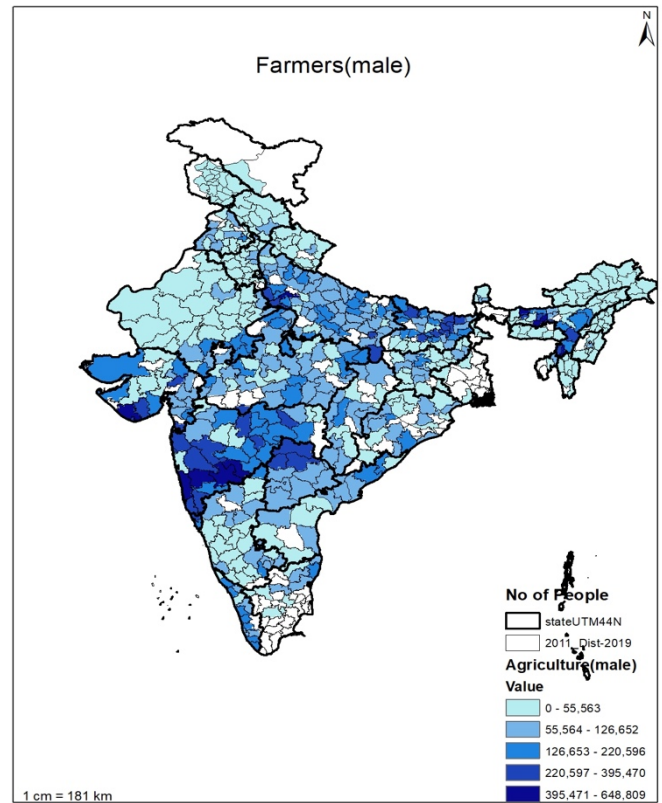
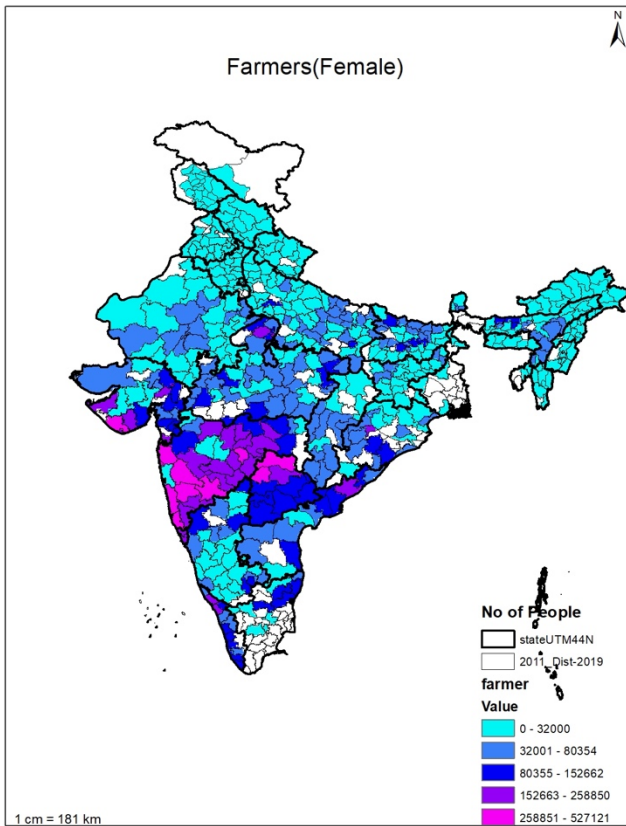


Figure xi District wise Number of Farmers

According to 2011 census ,Agriculture is still the largest source of livelihood for about 58% of India’s population. The agriculture practitioner can be divided into two major categories , (1)agriculture cultivators , and (2) agriculture labour . According to APED,43% of the total agriculture labour and 30 % of the total agriculture cultivator are female(fig -4)

In fig we can see that the largest number of registered Farmers in India were in the Districts of state Maharashtra and Gujrat .In the state of Uttar Pradesh , which is the largest state of India maximum number of districts are having registered farmer of 1 lakh to 3 lakh .It signify the importance of Agriculture in that state .If we see the India overall the higher density of farmer is visible in North India , one factor can be better soil and large network of Himalayan river system .

Now if we see towards the male and female land holding size , we can see that Number of Female land holders are less in overall India. Largest number of Female farmers are in the state of Maharashtra and in some district there number is higher than the registered male farmers . Similarly in the southern State of Kerala the female land holding is significant .Even Regional change is visible for example in the Border state of Rajasthan where the inland districts have higher female land holding then the desert districts .

Food Consumption analysis

The COVID-19 pandemic created a stern impact on the world wide food system. Different studies and surveys were conducted in many country to study the changes felt by the respective population. In this section we have studied different survey conduct in year 2020 regarding diet changes in India , along with that the consumption data was wclutied on the baes of offtae of food grain in various state by the population covered in public distribution system .

The COVID-19 stay-at-home order led to a higher demand for food ,people spend more money to stock up food supplies. Some cases led to panic-buying.(Loxton et al., 2020), behaviour.

We also conducted a separate analysis from state wise offtake data of wheat and rice by the population covered in Public distribution system . As mentioned earlier Public distribution system of Indian covers almost 75 % of the country's population. Data regarding the consumption of non-public distribution scheme covered was calculated from the indexmundi .

Methodology and observation

To study these changes , total cross -sectional studies were performed by different research(Alae-Carew et al., 2019) groups out of which 1 was hospital based and 9 community based ,conducting among Indian population with a various sample size from 110 to 1026 , the duration of these studies were from March to April. The targeted age group include people from 18–70 years, collectively 5400 people ,comprising 52% males and48% females.

We have performed an second analysis on consumption of Rice ,Wheat and vegetable due there pan Indian demand . This analysis was performed on the basis of daily arrival data of food commodities in 3252 private wholesale market spawn over 30 states of India. It is important to note that many of these markets or mandies as called in local languages were suffering from frequent shutdowns due to the spread of virus . However at national level they exempted from lockdown . Given that private markets have negligible or no amounts of export fluxes, we assume that all items arriving to private markets are destined to internal consumption.

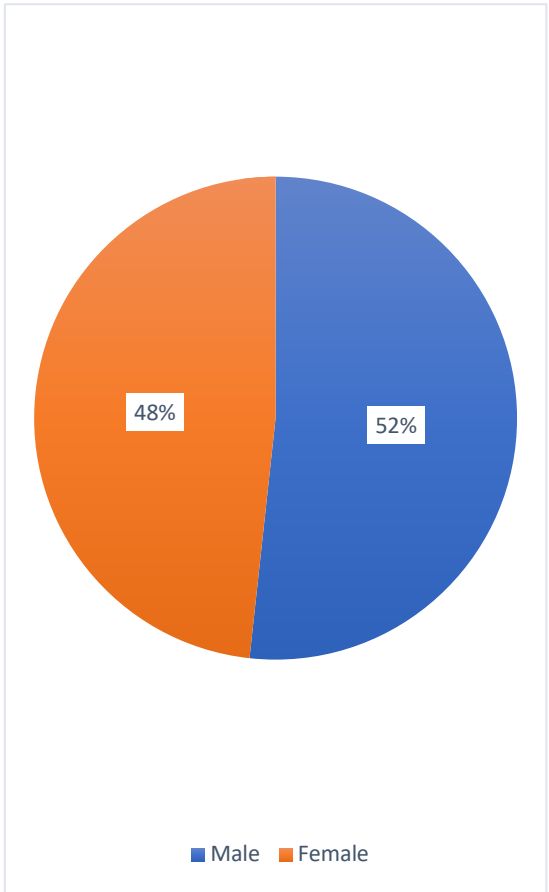
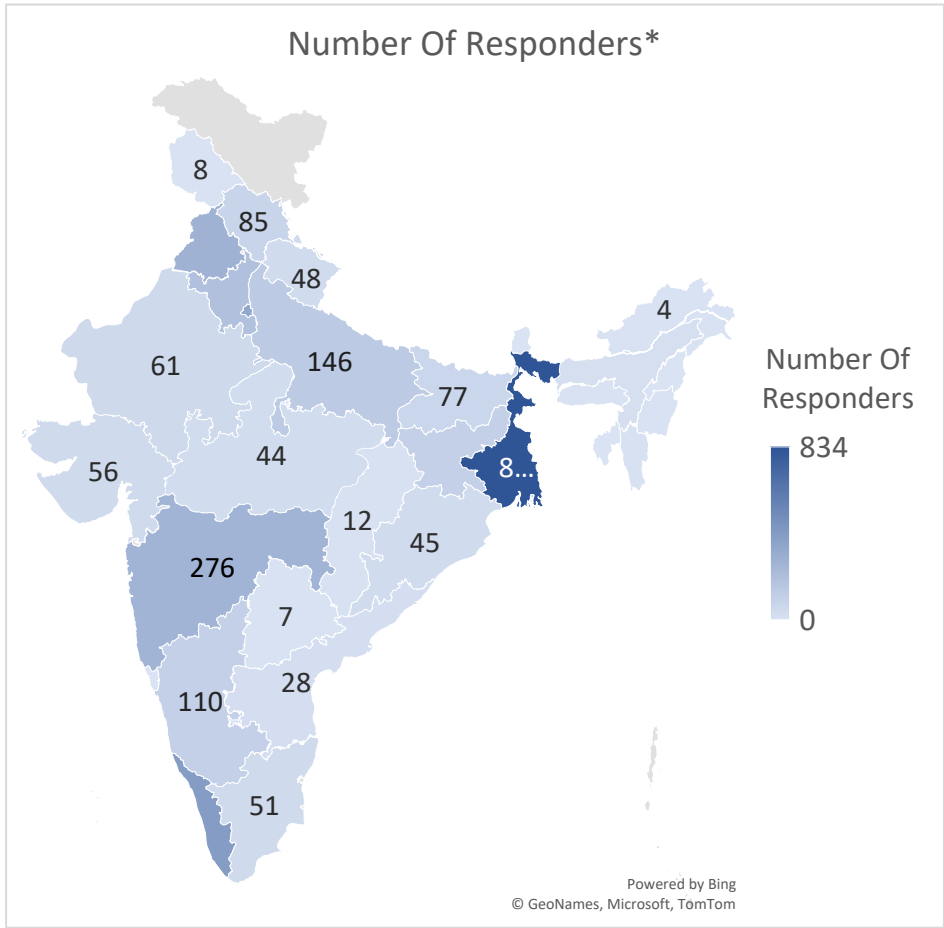
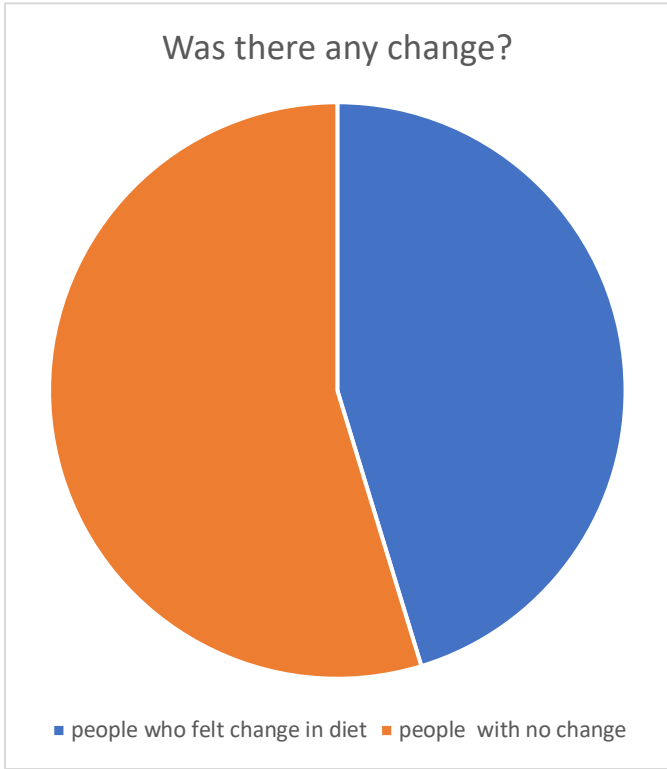
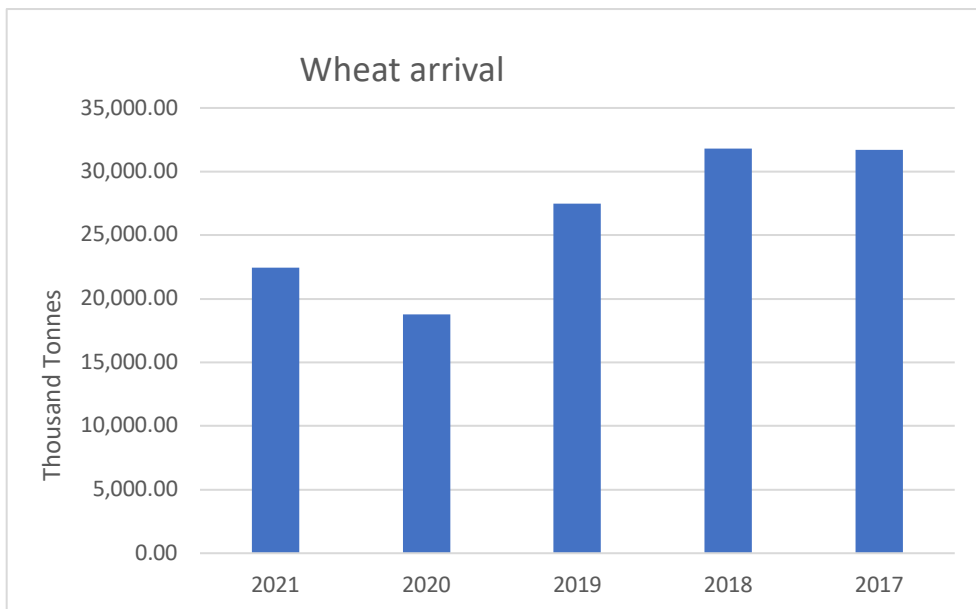


Figure xii Survey Regarding the consumption



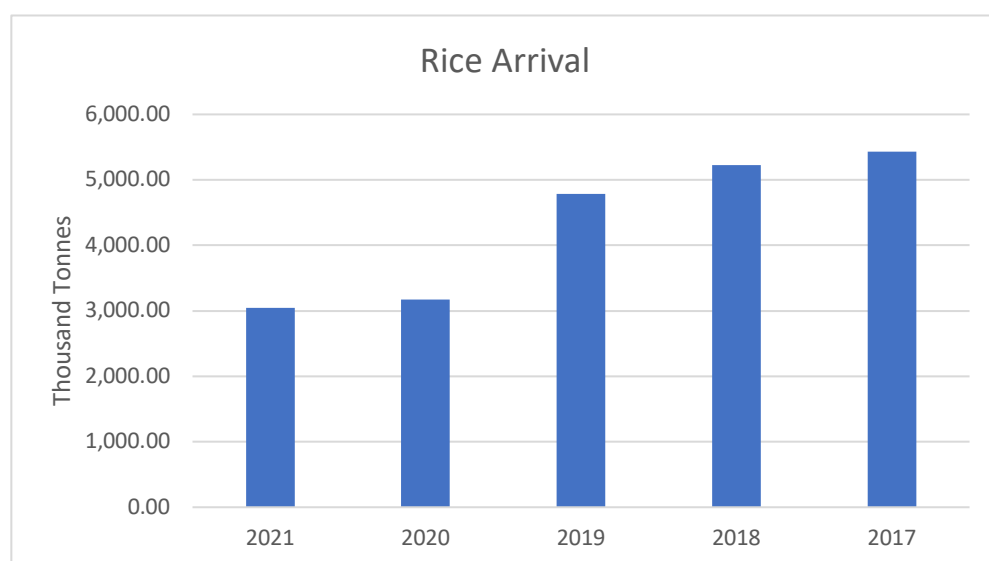
From the location of the responders we plotted the figure. Accept for the state of sakkim there was responder from each state . Urban rural ratio was equal in this study . largest number of responders were from the state of west Bengal 834 , followed by kerala 416 and maharshtara 276 .52% of the total responders were male ,48%were female .

The received outcome was 45% felt some kind of change in there ditery pattern , including incise of fruits intake , decrein the consumption of outside food . more then half the total respordess told that there didn't felt an change in their diet .

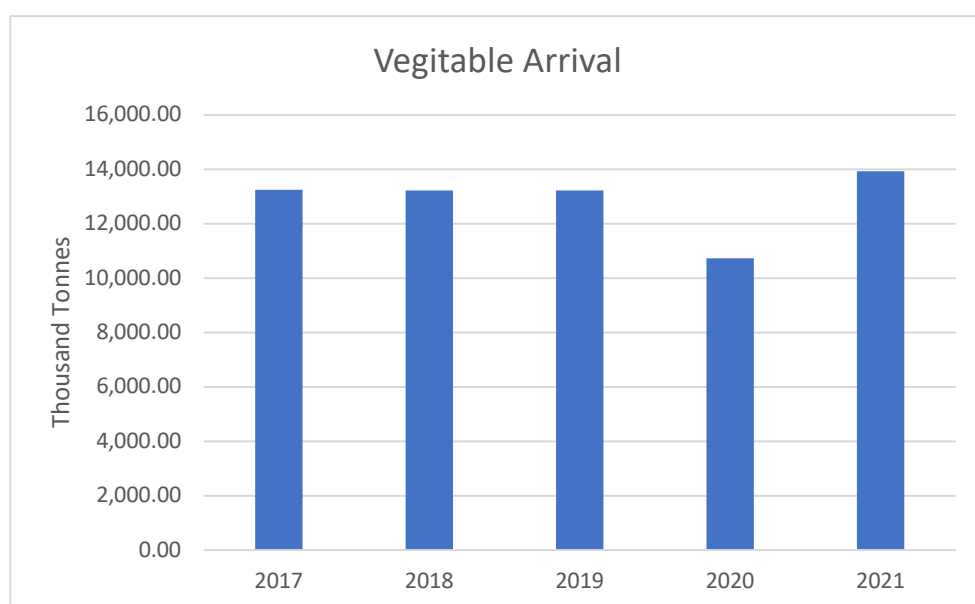


The amount of wheat arrived in the private market of India to fulfil domestic demand in 2020 was at 18000 *10³ tonnes in India . This amount ws lowest in 5five years .Next year in 2021 there an increase in this number.

In case of rice the amount of arrival was lowest in 2021 . There was steep fall in year 2020. the amount of rice arriving the market fall by 33% compare to the previous year.



Similar trend was noted in the Vegetables quantity arriving the market .In 2020 there was 19% reduction the consumption . However the number bounced back in 2021 and it was reported at the highest level in 5 years .



Conclusion

There was changes in dies which was see in the collective survey and this change in the diet was visible in the amount of food commodities arriving the markt . We can make this conclusion that in 2020 people large number of people was consuming led then what they use to consume, there can be different reasons for that , of

Figure xiiiArrival of Wheat ,Rice and Vegetable in Private market

them could be movement of migrant urban labour who work in thse markets and also a hawkers and vegetable sellers however a detailed analysis is required .

Effect Of lockdown and first wave on retail food prices-

Food security has three pillars, availability, accessibility and affordability. In the previous section we found that the production of the major food grain was high during the period of COVID-19, along with it the exports of food grains were also very high, by keeping these factors in mind we can say that there was no shortage of Food grain in India. From the offtake data of Public distribution system and the data from private market we also found that there was a record increase in the consumption of wheat and rice in almost every state of India. The production as well as distribution was maintained during the COVID-19 hence there were no high changes.

Affordability is the third pillar of Food security, it can be explained by the Nobel laureate Amartya Sen's idea of endowment and exchange entitlements. It stands for the ability to buy Food. There are different methods to calculate affordability however there is no stated one. We have used the wholesale price charts of the last five years of the month of June for wheat, pulses, rice and cereals. It is important to note that the Public distribution system is affected by the price fluctuation in the market.

Methodology

To fulfill the purpose of the study the Price trend was calculated at wholesale level and at retail level. The Wholesale Price Index (WPI) is used to measure the prices of selected wholesale goods. WPI is divided into three groups: Primary articles, manufactured products, fuel and power.

To calculate the rise in prices of food items in the retail market which represent the price at which a household purchases for its domestic purpose, we use the Consumer Price Index (CPI). CPI is designed to calculate the changes over time in the general level of retail prices of selected goods and services. It calculates the change in prices by comparing, through time, the cost of selected commodities. Annual CPI is used to calculate year-on-year inflation. Current series of CPI is calculated at the base year 2012.

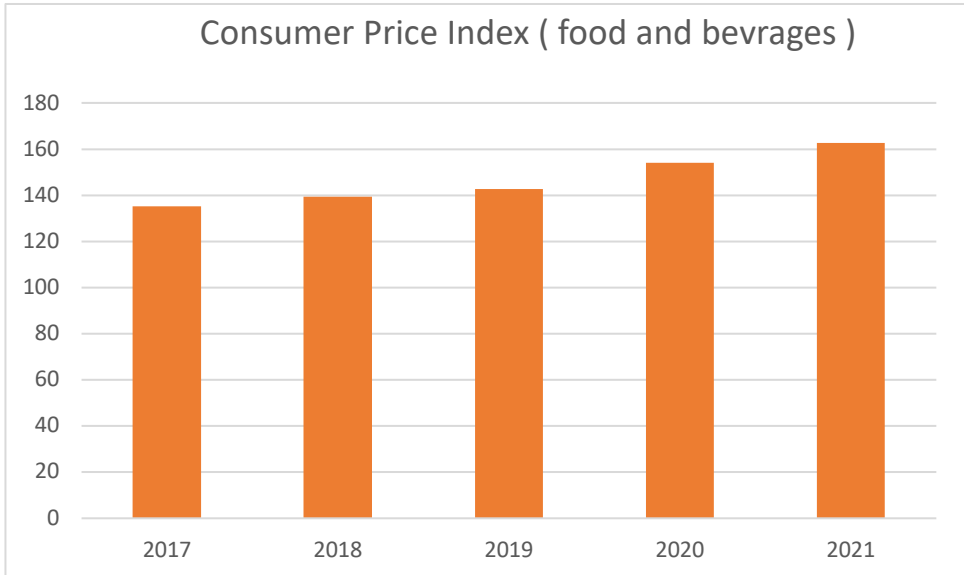


Figure xiv Last 5 years Consumer Price Index

Wholesale Price Index

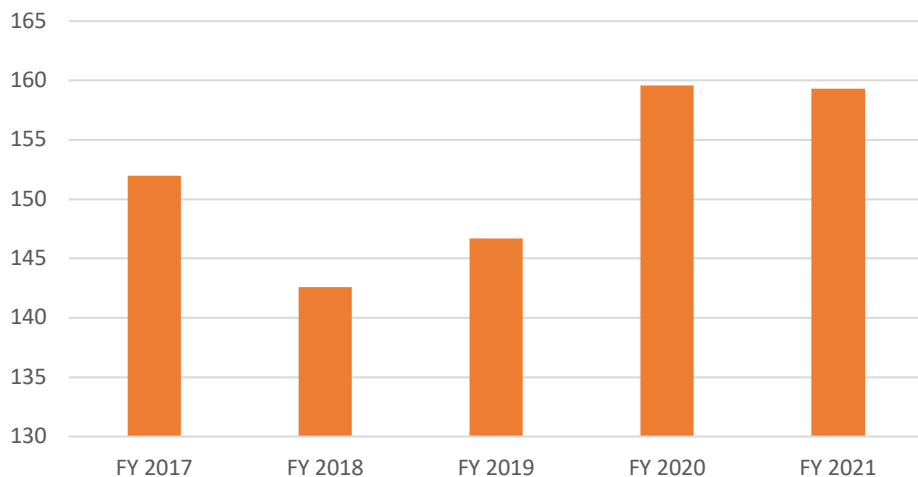
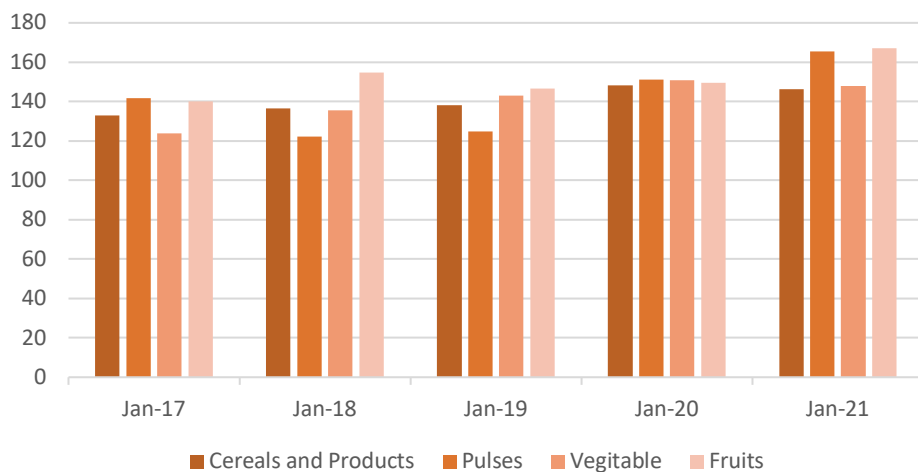


Figure xv Wholesale Price Index

Observation

In year 2020 the average Wholesale price index (WPI) of food commodities was 160 points at 2012 level. There was a 1 point reduction in 2021. Lowest prices were in 2018 when the WPI was at 143 points. From 2017 to 2020 there is 5.5% rise in the food prices.

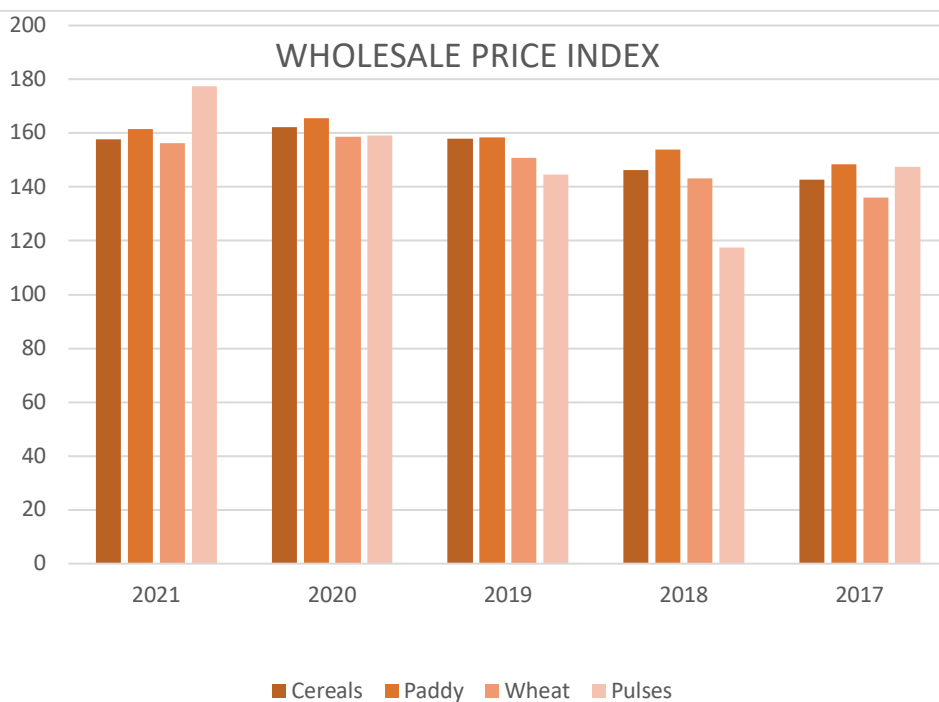
Consumer Price Index



If we compare this data with price trend of five major food grains then we found that the prices were also constant especially in 2019, 2020, and 2021. In 2018 there was major reduction in the food prices index and it is transferred in the prices of Pulses which was then at its lowest mark. However

Pulses showed sudden jump in 2021. The price of wheat was inflated by 12.8% in year 2021 compare to 2017, similarly 8.15% rise in paddy price was reported in 2021.

WHOLESALE PRICE INDEX



The consumer price index of food and beverage was at 154 points, It was 10 points higher than the previous year. In 2017 the index was at its lowest level in 5 years, followed by a gradual rise in prices in the consumer market. If we look at separate price index for some major food commodities, there was a trend of stable prices except pulses which

showed 25 point rise . And this trend was continue in 2021 . Consumer price Index also provide information about inflation in compare wit the base year. In 2020 there was a record infaionof 14 % in food price compared to 2017 and 8 % compared to previous year .

Conclusion

The primary objective to study and compare whole sale and consumer price indices was to evaluate whether there was steep rise in the food prices was there or not . From the data collected and the study we found that there was a trend of price stabilization in the whole sale market , which suggest that there was stable supply and no hoarding was done a large scale . However prices in the retail market was higher in compare to the previous years , which suggest that there was change in the demand at the retail consumer level and there was a supply obstruction at wholesale supplier to retail shop owner . This price rise noted only in the selected commodity like pulses.

With further detail investigation can reach to the bottom the cause .But it is safe to say that there was no drastic price changes both in retail as well as whole sale market .

1. Agriculture is still one of the most prominent sector in India , and it plays an important role in its domestic as well as international trade
Agriculture yield in India is highly uneven , there are few states which are producing more than entire country's output .
2. agriculture is largely a labour based industry and mechanization of farms is going on at a slow pace
3. No government was preprepared to deal with pandemic of such large scale .

Finally we can say that Covid -19 's effect was not much visible in food security sector as no area in India reported any acute shortage of Food items .

The above mentioned conclusions motivated the researchers to conduit this analysis made us curious whether the effect was there or not and which part of India was left untouched by the COVID-19 . As agriculture is complicated sector it was important to conduct this analysis in multiple dimension .

"The farmer is the only man in our economy who buys everything at retail, sells everything at wholesale, and pays the freight both ways."- John F. Kennedy

State wise wheat, rice Production in India during pandemic

In the previous chapter we explained the a brief history about Indian agriculture, how market works, log with the steps and various polices by the government of India for the betterment of agriculture . Later in the chapter we saw how covid pandemic changed the life of people , labour moment and steps taken to reduce the impact of COVID-19 on general public.

In this chapter we will study various analysis which were done by us to study the impact of COVID-19 pandemic on farming sector .It is important to note that the time frame of these analysis is from January 2017 to January 2021.This Section is divided on the bases on type of study , its respective methodology and observations . We have used Government provided data as a base for this study , no extrapolation was used while working on the study

Methodology

To study the production data we have taken the reports , data which are provided by the ministry of agriculture every year. These data are released in form of advanced Estimates and revised Estimates . (“India’s Food Grain Production,” n.d.).The Government of India releases 3 estimates in an year which projects the amount of production as well as the area of selected crops .These estimation are generally based on monsoon , global and domestic demand , area under harvest etc .

- The First Advance Estimate are announced in the month of September. These estimaskets are accnounced at ta time when the South-west monsoon season comes to a close .Same time the National Conference of Agriculture for Rabi Campaign is convened .Each state present there repective estimates and later these estimates are validated on the basis of inputs from the proceedings of Crop Weather Watch Group (CWWG) meetings, and other feedback such as relevant availability of water in major reservoirs, availability/supply of important inputs including credit to farmers, rainfall, temperature, irrigation etc.
- The Second Advance Estimates are announced in January . In the mean time the first estimates of the kharif crops undergoes revision and the area as well as production numbers .After the revision the second assessment of kharif crops are announced . *along with the second estimates the first estimate for the rabi crops* are also announced based on the feedback received from the States where sowing for rabi crops would have commenced during November- December.
- Third estimates are announced in the month of April , the National Conference on Agriculture for Kharif campaign is also convened
- The Fourth Advance Estimates are released in the month of July when the National Workshop on Improvement of Agricultural Statistics is held. In the month of July the harvest of rabi is officially ends and and commetie provide final estimates for both kharif and rabi seasons.
- Last and Final Estimate for the previous year crops are announced in December/January.

There is a large variation in crop seasons across the country due to diverse climate and cropping patterns. These factors result in the delay of compilation of yield estimates. As in the constitution of India, Agriculture is a State subject, which means states are free from their own rules and regulations on it. However, it often creates difficulty because, in order to get a correct and accurate estimate of crops and yield, the Central Government is completely dependent upon the State Governments for estimates.

Observation

In year 2020-21, overall food grain production in India was 303.44 Million Tonnes, which is 2% higher than the previous year when it was 294 Million Tonnes ("India's Food Grain Production," n.d.). If we take a look at Major crop Production, we see that almost every crop shows an increasing production in comparison with previous years. Most notable increase is in this

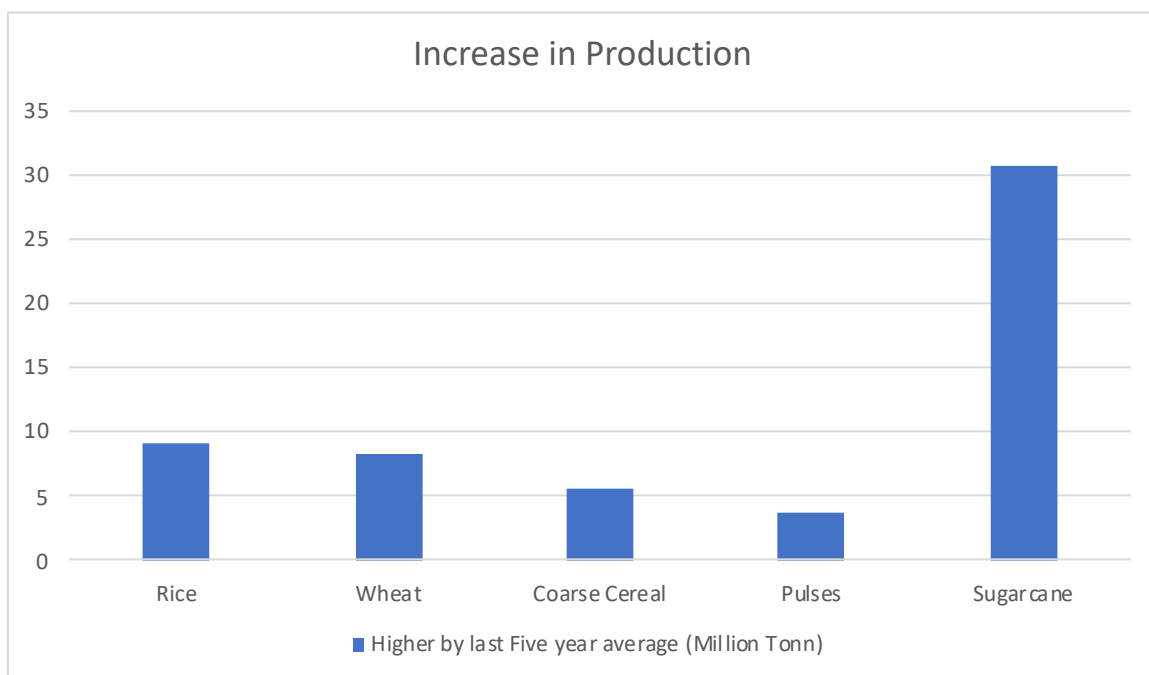
State (Rabi)	Decrease in Rice Production (Thousand Tons)	State (Rabi)	Increase in Rice (Thousand Ton)
MADHYA PRADESH	-3.63	BIHAR	5.84
HARYANA	-3.99	PUNJAB	3.98
ANDHRA PRADESH	-7.72	WEST BENGAL	7.68

Figure xvi State with the Largest Change in Rice Production

However, when we performed a detailed study of state-wise production of Rice and wheat in both the cropping seasons, we found that the increase in production is not universal. Many states performed poorly in 2020 and suffered from a reduction in

their harvest of both rice and wheat. To know more about this trend, we study the production of two

most consumed and produced crops in entire India, which is covered in its National Food Security Program - Rice and Wheat. This observation was done for the year 2020, and the results were compared with the 2019 calculation, and by taking into account



of monthly production data. These statistics were provided by (Department of Food & Public Distribution, n.d.)

State(Kharif)	Increase in Rice(Thousand Ton)	State(Kharif)	Decrease in Rice(Thousand Ton)
TAMIL NADU	10.4	WEST BENGAL	-3.61
TELANGANA	7.58	UTTAR PRADESH	-0.27
ODISHA	6.26	PUNJAB	-10.43
ANDHRA PRADESH	4.24	MAHARASHTRA	-3.78
		ASSAM	-2.36

.In below table we provided name of states which shown highest change in term of production for Rice and Wheat in both crop session

From the above tables we observe that during the year 2020 , kharif production was a very high variation in compare with the kharif production in 2019 , for example All the three states which shown highest increase in the production of kharif crop from southern India similarly all the states which shown highest decile in the production belongs to northern India .However if we look toward the Rabi crops the study show that both the crops don't show a such clear geographical pattern and on the contrary all the states which shows change in production are from north India. Wheat which is a single session crop show a tremendous increase in the production in state of

Uttar Pradesh and Punjab show a decrease in production

State	Increase in Wheat Production(Thousand Tons)	State	Decrease in Wheat Production(Thousand Ton)
UTTAR PRADESH.	36.24	PUNJAB	-6.87
MADHYA PRADESH	17.06	JAMMU & KASHMIR	-4.87
RAJASTHAN	16.66	ASSAM	-0.05
HARYANA	15.99		

Conclusion and results.

As the The period was classified as pre covid and post covid, however it Is import to remember that first nation-wide lockdown was imposed by the government of

Indian on 24th of march , which was in the middle of the harvest session of Wheat . So it is safe to assume that The first lockdown must not have affected the production of food grain especially wheat because the sowing month is January . However June and July is the major sowing session

Figure xvii State with the largest Change in wheat production

to rabi 2020.

During the Winter cropping session (rabi), the north Indian states showed large variation in production in compare to south . however the reduction in the rabi production was less . hence we can say that the agriculture and farmers were trying to revive and bounce back from the state back they felt in kharif sessions which was under lockdown .One reason which we assign to this result is that by the end of September all the major travel restrictions were removed In India and migrants labours went back to there working state .

Crop Area analysis by NDVI

Crop production statistics are released only at the end or beginning of cropping session. Hence they do not provide month on month variation data which leads to their limitation of not taking account the temporal variation such as crop delay, crop harvest lost due to meteorological conditions etc. Realtime District wise monthly data of crop statistics is very difficult to access, due as the digitalization of data has not been achieved throughout India.

Remote sensing plays a pivotal role in generating the crop production data. To overcome this problem we have used satellite remote sensing images, with NDVI (Normalized Difference Vegetation Index) with the help of ARC GIS at state and district level.

Methodology

Satellite remote sensing is an effective way to overcome the lack of realtime detailed ground reporting of agricultural, thus allow us to independently monitor large crop area and production (Milesi et al., 2010).

In previous years many indices and methods were developed in order to calculate the land cover and vegetation percentage in an area. NDVI is the most commonly used. NDVI or Normalized Difference Vegetation Index is calculated on the basis of the absorption of incident solar radiation in the red (RED) spectrum band through the chlorophyll and scatter in the near-infrared (NIR) spectrum band through the spongy mesophyll (Rouse et al., 1974).

$$NDVI = \frac{NIR - RED}{NIR + RED}$$

Table v NDVI classification

Feature	NDVI(range)
Water	-.413 to -.104
Build-ups/River sand	-.104 to .055
Fallow, Wasteland	.0557 to .205
Crop, Grass	.205 to .370
Agroforest	.370 to .510
Forest	.510 to .820

The value ranges from -1 to 1. Negative values represent areas entirely covered with open waters and positive values represent the areas enclosed by green vegetation. (Rouse et al., 1974).

NDVI ranges were classified six features namely water , build-ups , fallow wasteland ,crop ,agroforest and Forest (Rizvi et al., 2009),(Miles et al., 2010).

We performed Bi-monthly analyse from January 2017 to January 2021 with help of satellite Images from the Bhuvan (ISRO, 2020) ,which is an Indian web based utility which allows users to explore a set of map based content prepared by Indian Space Research Organization . However the content which the utility serves is mostly restricted to Indian boundaries and is offered in 4 regional languages. The content includes thematic maps related to disasters, agriculture, water resources, land cover and also processed satellite data of ISRO

The satellite which provided data is Indian Space Research *Organisation 's remote sensing satellite OCEANSAT2(Oceansat-2-Brochure-1.Pdf, n.d.)*(Bhuvan & Sdapsa, n.d.).

For Image processing and data classification we have used ARC GIS and MS excel. *For the spatial analysis , shape file of Indian states and districts were masked upon the Raster map . which resulted in generating area under each state ,for each feature in its respective map*

Satellite

Oceansat-2 was launched on September 23, 2009 by ISRO . The primary objective of this satellite was to provide spaceborne data for applications ,pertaining to ocean and meteorology studies.

The satellite consist Ocean colour monitor (OCM) which works in the Visible-Near Infra-red (VNIR) spectral range with 360 m spatial resolution and 12 bits per pixel radiometry for operational use of generating products for identification of potential fishing zones.The other two sensors are Ku-band scatter meter which is used for the estimation of ocean wind parameters along with a Radio Occultation Sounder for Atmosphere (ROSA) meant for atmospheric analysis.

Study Region



Figure xviii Map of India

In this study we have covered both irrigated and rainfed croplands within the territorial and administrative boundary of India (Maps, 2020). It is carried out at a spatial resolution of 10 km by 10 km. This analysis includes 631 districts of India along with a separate map for 30 states of India. It lies between 20.5937° N, 78.9629° E. The area with value zero was omitted from study. This study also includes the marshy land of the State of Gujarat (Ranna of Kutch) which is partly submerged during the high tides.

Observation

Total of 8 GIS maps were prepared on the basis of the bi-monthly satellite images from January 2017 to June 2021. To capture the change in area under agriculture more precisely we have classified the maps on the basis of cropping season. For Kharif crops September months NDVI map was made and for Rabi November. This decision was made on the fact that the government of India announces the Minimum Support Price (MSP) of Kharif and Rabi crops (Organisation, n.d.). As mentioned earlier, this is the price at which a farmer can sell their upcoming crop to the government. Along with it, September and January are the middle of the harvesting season, which makes crop size perfect for vegetation analysis.

Computation of area was done both at state as well as district level.

The crops that are sown in the rainy season are called Kharif crops. (also known as the summer or monsoon crop) in India. Kharif crops are usually sown with the beginning of the first rains in July, during the south-west monsoon season. The crops that are sown in the winter season are called Rabi crops. (also known as the “winter crop”) in Pakistan and India.

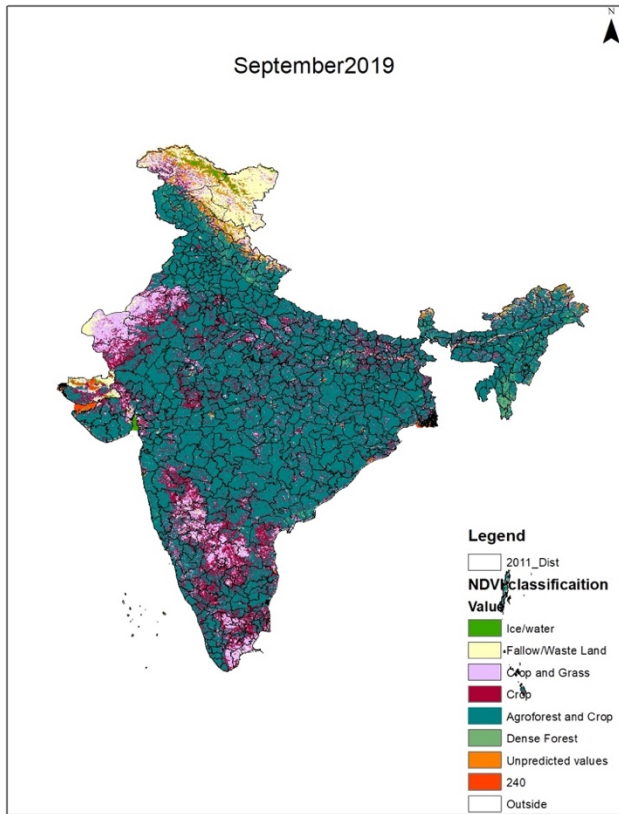


Figure xix NDVI map of Kharif 2019

From this map we can see that by the end of

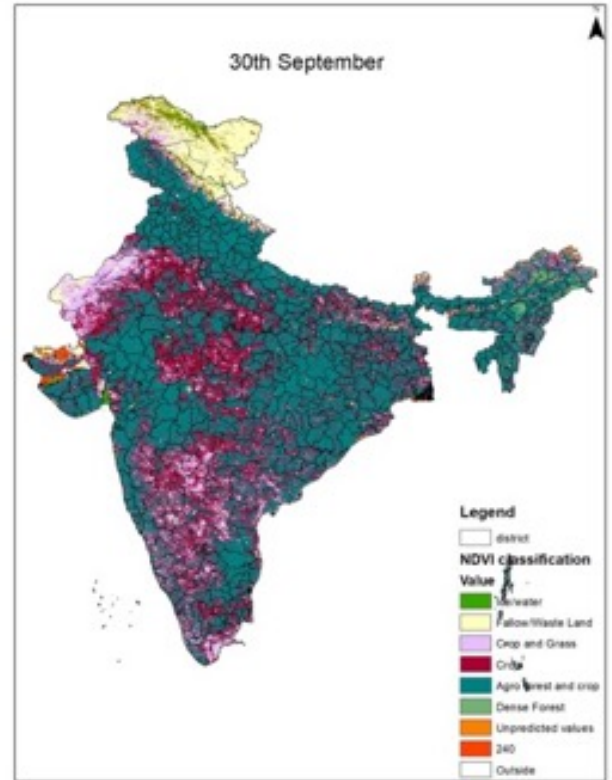


Figure xx NDVI map of September 2018

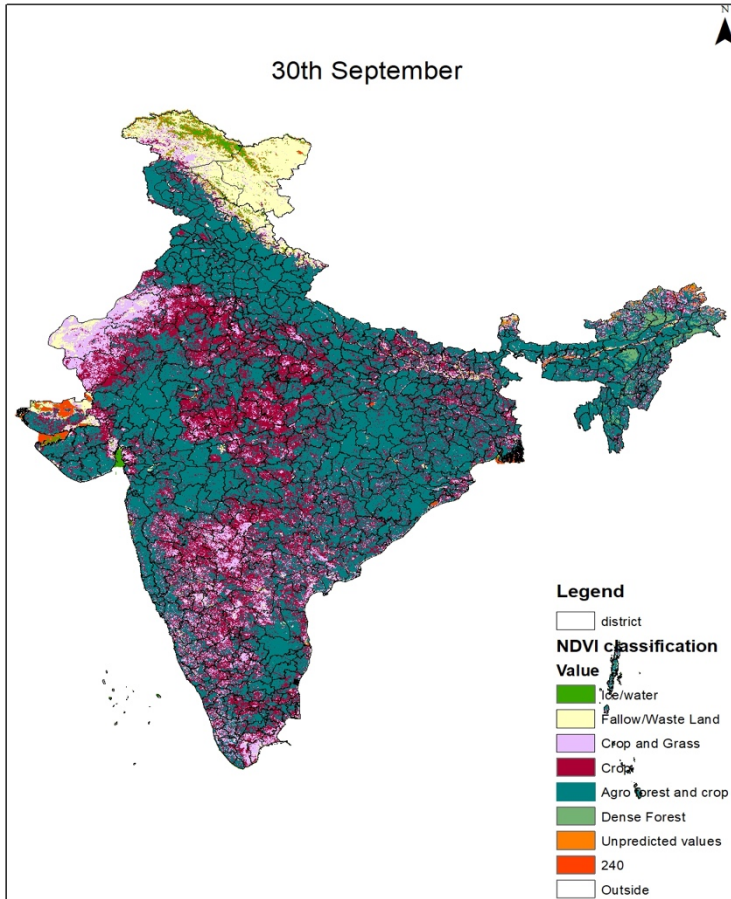
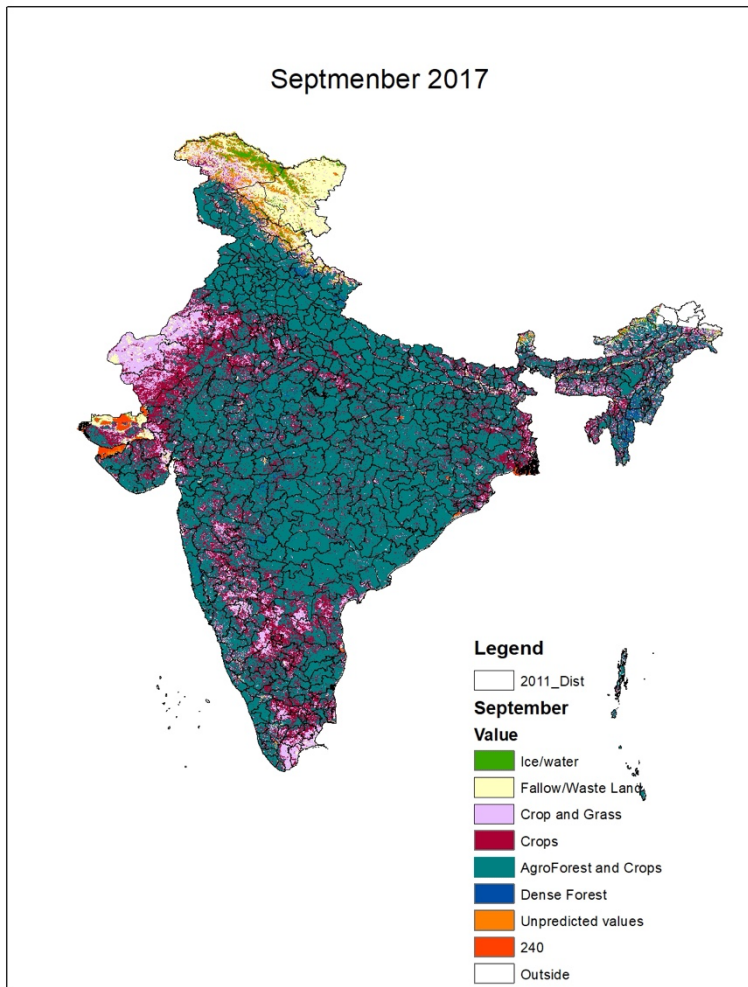


Figure xxi NDVI map of September 2020

September 2019 almost entire India is covered in the green colour which represent healthy vegetation with second highest refractive index . As we know NDVI measures the state and health of crops or crop vigour. This vegetation index is an indicator of greenness and has a strong correlation with green biomass, which is indicative of growth. The central part and northern part of India receives monsoon from in July due to which by the end of September the crop planted In monsoon reaches till a good height . However in South India receives rainfall in the winter or better known as receding monsoon . Due which the cropping pattern is different . But in the well irrigated area and the basin of major rivers such as Kaveri and Krishna Cropping is done all year round which can see in the map . It is important to note that in the western part of India near the Arabian sea , the area is Represented by Red colour which represent presence of water or brackish land ,as this area is constantly go under tidal cycles.



In this image we can see that the central part of India having less area under high green vegetation then the area under crop and grass . Whereas in the southern part of India similar observation can be seen in southern central part of India. if we see in state wise we can see that. Rajasthan , Karnataka Madhya Pradesh are the largest state with the largest area under agriculture . Similarly Punjab Chandigarh and Haryana are among the big state with least area in farming and agriculture With more area under crop and grass category , it can be due to late sowing of seeds due to which by the 30th of September plants didn't reach to their maturity . This can happen due to the delay of monsoon and a weak monsoon , more detailed analysis was done in the later part of the this section.



Figure xxii NDVI map of September 2017

The satellite image of September 31st was used to create this map . A large area of India was covered in agriculture and agroforestry . The extant of farming belt can be seen from Punjab to northern states . There are few visible patches of fallow land the southern sate of Karnataka and Tamil nandu border . Similarly the western part of Rajasthan .

in 2017 we found that the rainfall was normal and the agricultural yield for food carp was also very high. This results are supported by the satellite of 2017 . If we compare 2017 with other years we can see that the green cover is max in 2017 .

There is a visible difference between the green cover in 2020 and 2017 . in 2017 there was less visible fallow land in all over India however In 2020 the area under in grass and young crops are more then previous years . Most visible change is is in the southern states .We can make observation from the map that, large part of central India went through late farming and late sowing compare to the other regions .

Figure xxiii NDVI map of September 2017

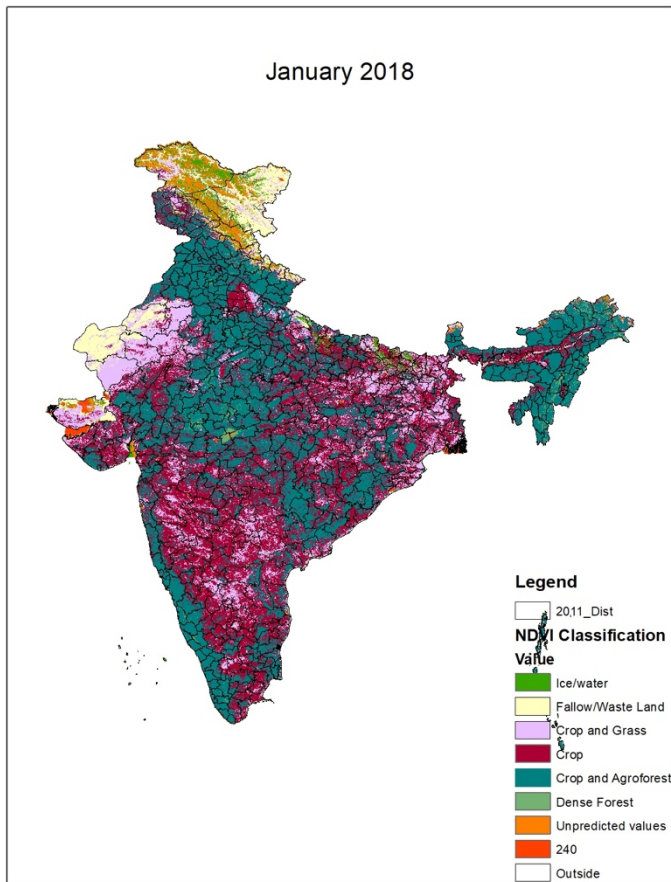


Figure xxiv NDVI RABI 2018

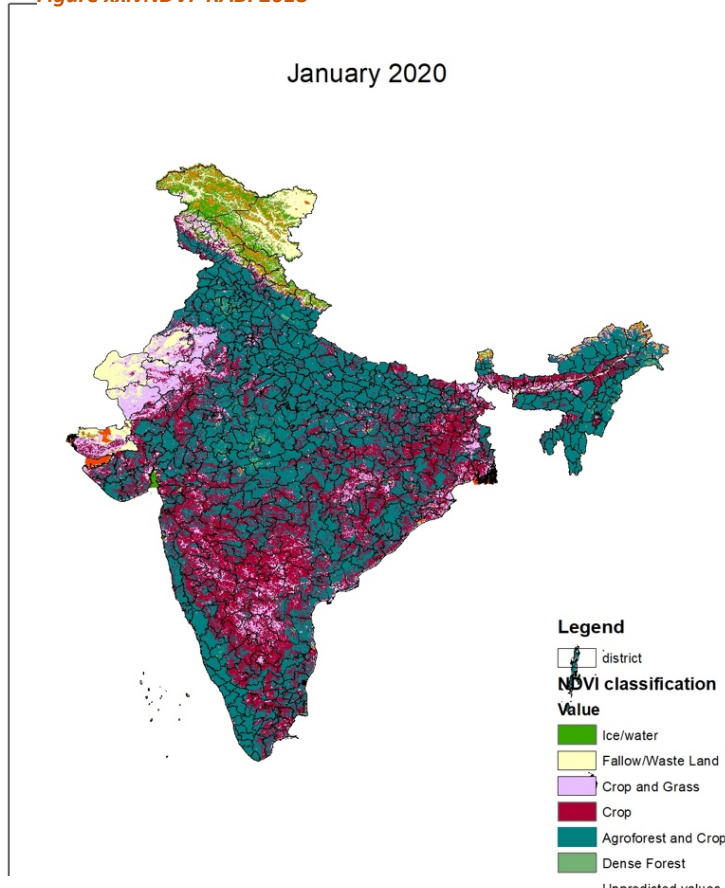


Figure xxv NDVI Rabi 2020

This map was created on the basis of the data calculated on January 2018 .In this map we can see that in the January month North show majorly only two vegetation index , one is green which indicate tall plants and agro forest and lite pink which is a representative of small crops , and grass . However in south India other than green dark pink is the second index which is prevalent .Which is symbol of medium height crop and slightly mature vegetation index . Therefore we can make this conclusion that winter cropping Is more prevalent in south India , and the plantation /sowing of seeds is done at the end of the monsoon . If look in the terms of exact value Maharashtra and Rajasthan are the two highest area under agriculture state for this month in year 2018 .

This map was created on the bases of satellite image taken on 31st January 2019.It can see that in 2019 farming pattern of North India was virtually similar to the previous year .The state of Rajasthan Showed major area was covered with crops and grass. This pattern is visible in the state of Gujrat too . Rest of the north India is cover with agro forest and high vegetation Index crop. In South central part of India large number of area is Under young crop and grass as well a sparse vegetation . Rajasthan , Maharashtra , Gujrat is the states which show large area under agriculture .

This map was created on the Basis of Satellite image taken on 31st of January 2020 . it

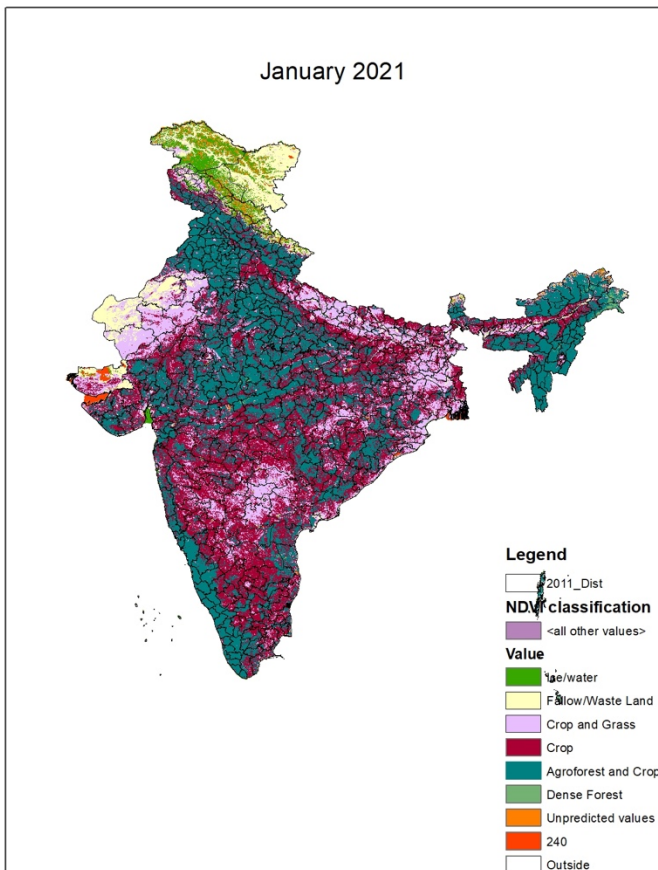


Figure xxviNDVI RABI 2021

Important to point out that the first case of covid 19 in India was register in the month of jauray 2020. From the maps we can see that The Himalayan state of Jammu and Kashmir was covered in Ice and snow , visually is looks like this is the largest area under snow in last 4 years . However further analysis is required to support this fact .In this we can clearly se the basin of River Brahmaputra which lies in the northern east part of India . In January 2020 other the Rajasthan almost entire north as well as south India was under cultivation and crops were of mature age . With this can assume that the monsoon was good and plantation was started approx. in same month , .Rajasthan ,Maharashtra , Karnataka , Andhra Pradesh are .has the largest area under agriculture

This map was created on the basis of the satellite images taken on 31st of Jan 2021 .It is visible, that

eastern part of India , especially the state of Up which is a border state of Nepal . has a large area under crops and greases . whereas southern central part of India is covered with mature crops. Similarly the central India is covered with agro forest and Crops

Maharashtra , Rajasthan and Madhya Pradesh are the state with the highest area under agriculture and crop.

Result and conclusion

From the The GIS maps we were able to calculate te area un der agriculture in each districts of India Furthermore we summed up all the agriculture area of each districts . From the data of non covid

years 2017, 2018, and 2019. When comparing it with the COVID year 2020, we found that there was a reduction in the area under agriculture in a maximum number of districts for both September and January months.

In January months, all the districts of Punjab and Kerala showed an increase in the area under agriculture, while many districts of Uttar Pradesh, Rajasthan, and Uttarakhand showed a reduction in the area.

Kharif crops are largely rain fed they are sown before the onset of Monsoon .

Agriculture is the backbone of India's economy. According to the census 2011, approx, 70% of the India's population depends directly or indirectly on agricultural activities for their livelihood.. Rainfall occurring over India during summer monsoon season (the major rainy season generally starts in June and ends in September) .The south west or summer monsoon is major factor which not only affects the agricultural production of the country but also the industrial output and even stock market . South west monsoon is the major source for water for the two main crop growing seasons, Kharif (summer) and Rabi (winter). Variations in the monsoon rainfall affect the total food grain yield of India and also the country's economy, which largely depends on agriculture((Krishna Kumar et al., 2004).

The importance of Monsoon rainfall in Indian agriculture can be understood by the fact that even though modest decrease of 10% of long term mean rainfall leads to significant decrease in rice production over India (Krishna Kumar et al., 2004)

However two monsoon systems arrive over the Indian subcontinent. The summer monsoon better known as southwest (SW) monsoon and northeast (NE) monsoon which is also known as retreating monsoon or winter monsoon. The SW monsoon has been studied widely compared to the NE monsoon. Post-monsoon season or simply the northeast monsoon rainfall (NEMR) season (OND) over south peninsular India and Sri Lanka is the major rainfall season((*Foreshadowing Northeast Monsoon Rainfall Over Tamil Nadu, India in: Monthly Weather Review Volume 111 Issue 1 (1983)*, n.d.), which helps agricultural production in this region

While most parts of India receive nearly the entire portion of their annual rainfall during SWMR(V. Prasanna, 2014), the southeast peninsular India falls under the rain shadow region during the summer season due to the presence of Western Ghats. This region therefore critically depends on the NEMR to supplement the inadequate precipitation during SWMR(V Prasanna, n.d.). Over the south-eastern tip of the Indian peninsula and neighbouring Sri Lanka, nearly 50% of the annual rainfall is received during the NEMR season ((Venkatraman Prasanna & Yasunari, 2008).

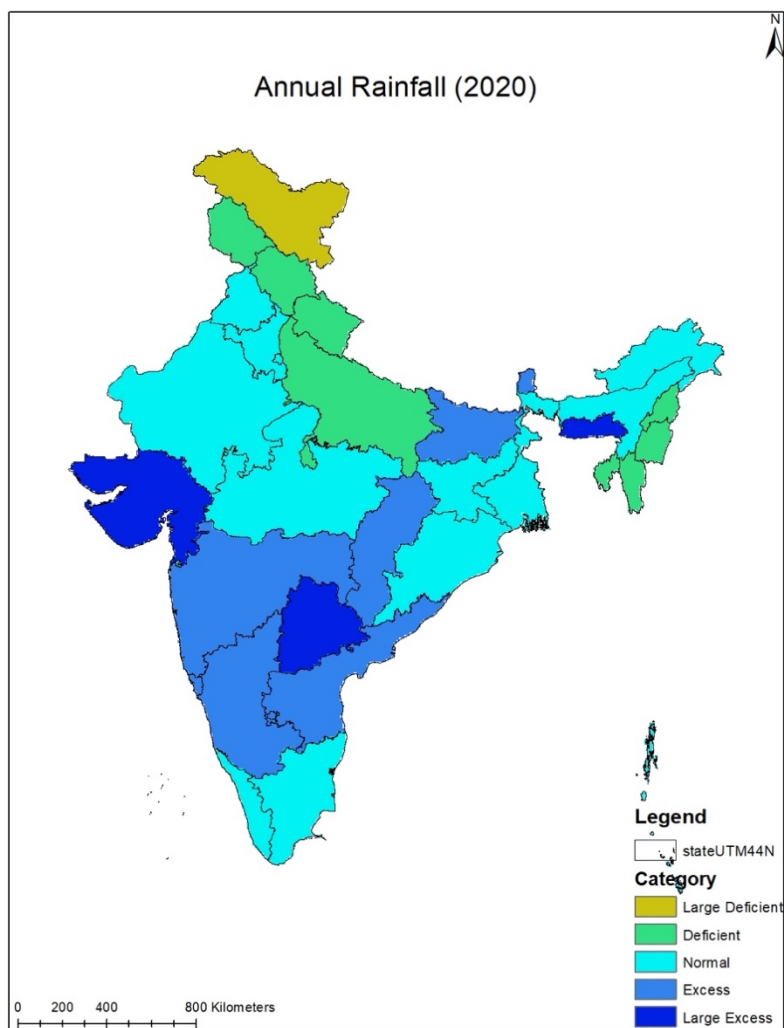
<i>Category</i>	<i>Rainfall from Normals</i>
Large Excess (LE)	<i>60% or more</i>
Excess (E)	<i>20% to 59%</i>
Normal (N)	<i>-19% to +19%</i>
Deficient (D)	<i>-20% to -59%</i>
Large Deficient (LD)	<i>-60% to -99%</i>
No Rain	<i>-100%</i>
No Data	<i>Data Not Available</i>

Table vi Ranfall classification

Methodology

Every year the meteorological department of India collects data of daily annual precipitation, later this data is published in form of annual review. The data regarding the annual rainfall in different states of India for the years 2011, 2018, 2019, and 2020 was taken from each rainfall centre. Later this data was classified on the basis of the location of these centres in a state. From these data, we used to prepare GIS maps for the respective years. To avoid any misrepresentation of data, rainfall throughout the year was used in place of Monsoon rainfall.

As the main focus of the study was to see the variation in the rainfall throughout the year, we have calculated the percentage of variation or change that each state showed annually. The output of this analysis was classified on the basis of Percentage variation, from the nominal rainfall. Normal Rainfall is calculated on the basis of rainfall records of 50 years (1961-2010) of a network of Rain Gauge Stations all over India.



The annual rainfall received through out the country was 110% (128.9cm) of its normal rainfall of 118.7 cm.

Whereas during the south west monsoon season India received 96.1 cm of its normal rainfall of 89 cm. During the Winter monsoon 20 cm rain fall was recorded . It may be observed that departure of actual observed rainfall for both the for South west Monsoon season and annual rainfall was positive for the country.

States of South India largely received excess rain fall , except from the state of Kerala and

Figure xxvii Rainfall map for 2020

	R	MONSOON	SW MONSOON	POST-MONSOON	ANNUAL
COUNTRY AS A WHOLE	-1%	21%	9%	1%	10%
NORTHWEST INDIA	-13%	32%	-14%	-39%	-10%
CENTRAL INDIA	87%	104%	15%	13%	19%
SOUTH PENINSULA	-37%	-4%	29%	15%	21%
EAST & NORTHEAST INDIA	-6%	7%	7%	-14%	6%

Table vii Region Wise departure of Rainfall 2020

tamilnadu. showed maximum . The south west-monsoon rainfall in southern state was +29% compares to the Normal totaling 93.4cm. Ganga basin, state of Punjab and hariyan received defecate rainfall along with four northeastern state .

The annual rainfall received by the country in 2019 was 128.9cm where as the normal rainfall was 118.7 cm. From the South west monsoon India received 97.2 cm the normal rainfall was 89 cm. In 2019 Central India there was 29% positive departure in the south west monsoon season monsoon rainfall .Other regions like central India , south peninsula reported positive variation both annually and during Monsoon season,.However there was a , -ve % variation from Normal for East and Northeast region..

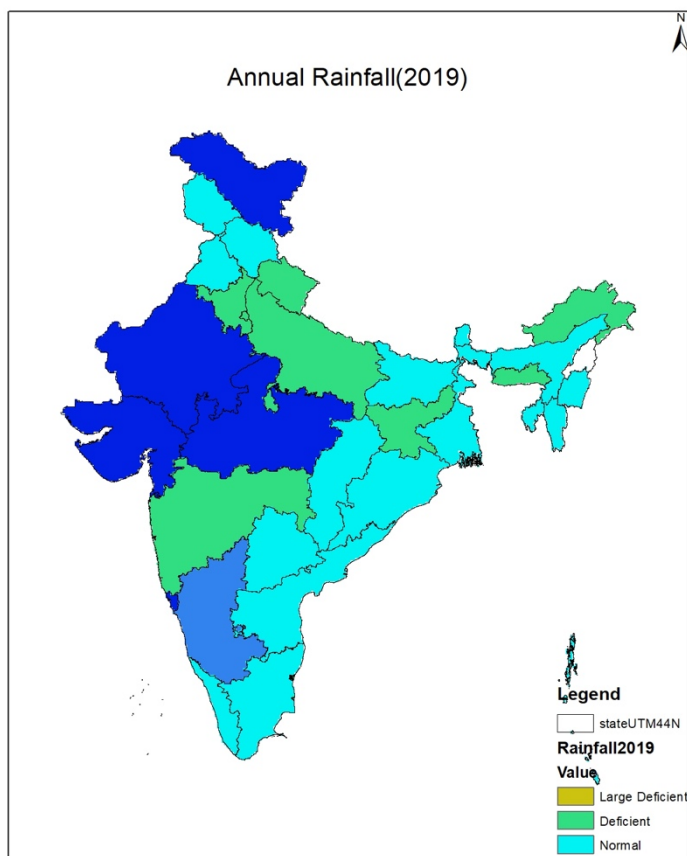


Figure xxviii Rainfall Distribution 2019

Which results in the normal to deficient rainfall . South Peninsula India experienced the highest negative % departure (-46%) of observed rainfall during Pre-Monsoon season and Northwest India had highest positive % departure of observed rainfall (55%) during the Winter season State wise seasonal and annual observed rainfall, and its percentage variation from normal rainfall, it may be seen that, Dadra & Nagar Haveli (UT) was with the highest positive variation of 70% from its normal whereas Manipur remained with highest negative departure (-54%) from normal.

state's

REGIONS	WINTER	PRE-MONSOON	SW MONSOON	POST-MONSOON	ANNUAL
COUNTRY AS A WHOLE	26%	-22%	10%	30%	10%
NORTHWEST INDIA	55%	-31%	-1%	78%	6%
CENTRAL INDIA	-25%	-14%	29%	64%	31%
SOUTH PENINSULA	-20%	-46%	16%	16%	4%
EAST & NORTHEAST	-9%	-9%	-12%	-5%	-12%

received excess rainfall and 3 states received deficit rainfall ,rest of the states were normal.

2018

The country received annual rainfall of 86% (102.08cm) of its normal rainfall of 118.7 cm and during SW monsoon season, 91% (80.41 cm) of its normal rainfall of 89 cm.

It may be observed that four homogeneous regions as well as the country received negative % variation of rainfall during all the seasons and also annually ~~except~~

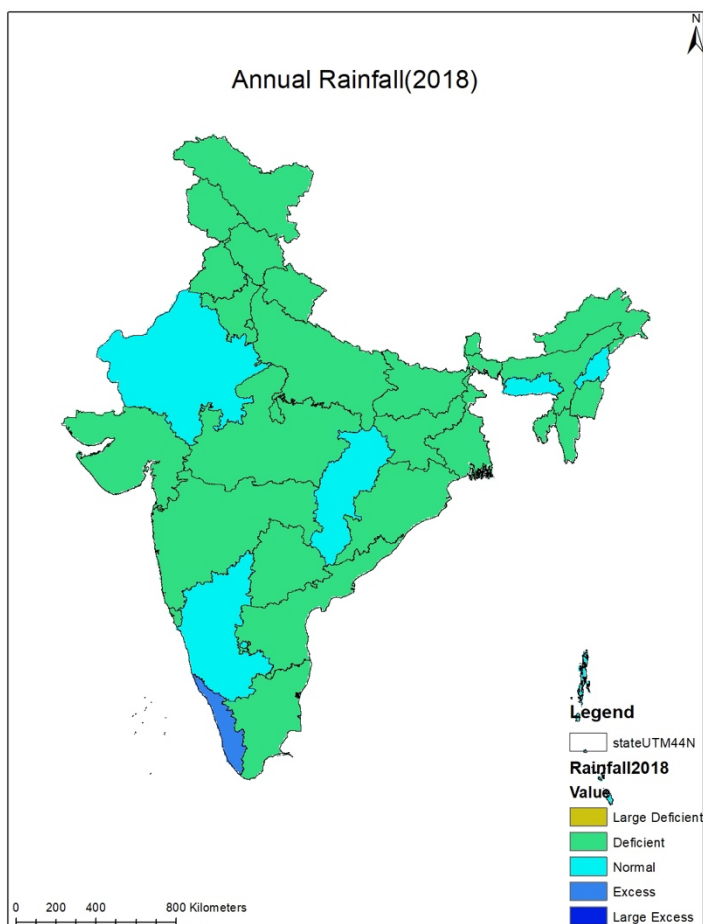


Figure xxix Rainfall distribution 2018

peninsula it is positive % departure during pre-monsoon season only. The country was at maximum deficiency in rainfall of 62% during Winter season. Regionally, lowest negative departure (67%) observed over Northwest India region during winter season whereas highest positive departure of 32% was observed in South Peninsula region during Pre-Monsoon season. During SW Monsoon season, lowest rainfall deficiency (-25%) observed over East & Northeast India, whereas maximum -2% departure observed over south peninsula and northwest India region. If we look at the state wise data , Kerala was with the highest positive departure in rainfall of 20% from its normal whereas Meghalaya remained with highest negative departure of 34% of its

normal rainfall. 2018 we found that almost entire India received less rainfall then normal . Just from the monsoon alone country received 445 less rainfall then normal .

REGIONS		WIN	PRE-	SW	POST-	ANN
		TER	MONSOO	MONSOO	MONSOON	UAL
			N	N		
COUNTRY	AS A	-	-7%	-9%	-44%	-14%

WHOLE	62%				
NORTHWEST INDIA	- 67%	-28%	-2%	-44%	-14%
CENTRAL INDIA	- 58%	-6%	-7%	-50%	-10%
SOUTH PENINSULA	- 43%	32%	-2%	-37%	-7%
EAST & NORTHEAST INDIA	- 57%	-12%	-25%	-52%	-23%

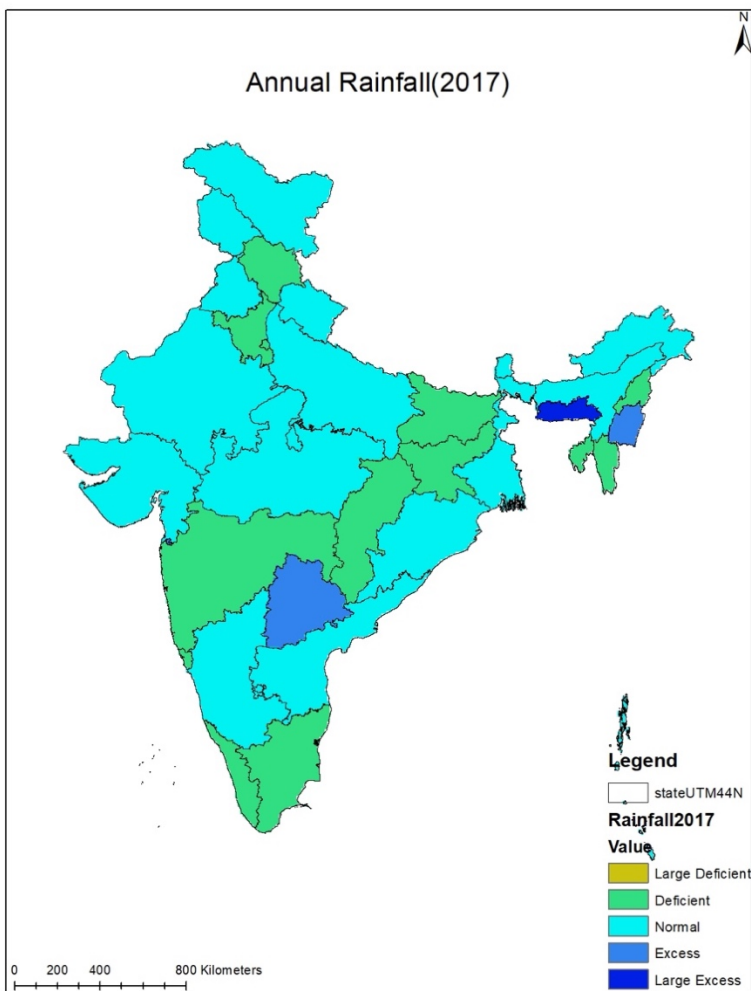
Table ix Region wise Departure of Rainfall 2018

2017

In 2017 India received annual rainfall, of 112.7 cm. Whereas during South west Monsoon season, 95% of its normal rainfall which is 84.6cm. When we compared the percentage variation from normal rainfall we found that the Central India, Northwest India as well as the country as a whole received negative % departure of rainfall during all the seasons and also annually. Also, South Peninsula also received negative % variation of rainfall during all the seasons except SW Monsoon which zero % variation. E & NE India during Pre-Monsoon, Post-Monsoon and annually received positive % of departure of rainfall whereas winter and sw-monsoon received negative % departure of rainfall. Annually, all the regions and country as whole remained with normal rainfall category. In the different State the annual rainfall was found

Figure xxx Rainfall distribution 2017

that Mizoram was with the highest



positive departure in rainfall of 47% from its normal whereas Uttar Pradesh remained with highest negative departure of 32% of its normal rainfall. Meghalaya recorded departure of positive 17% in rainfall and Haryana remained at negative 25% deficiency in rainfall. 5 states were under deficit a rainfall, 1 under excess and rest of the country was under normal rainfall

Table x Region wise departure of Rainfall 2017

REGIONS	WIN TER	PRE- MONSOO N	SW MONSO ON	POST- MONSOON	ANNUAL
COUNTRY AS A WHOLE	-5%	-2%	-5%	-12%	-5%
NORTHWEST INDIA	33%	-8%	-10%	-56%	-9%
CENTRAL INDIA	- 82%	-41%	-6%	-9%	-8%
SOUTH PENINSULA	- 15%	-9%	0%	-11%	-4%
EAST & NORTHEAST INDIA	- 54%	14%	-2%	17%	1%

Conclusion and results

In past four years Indian mooson was normal. There was a negative departure of annual rainfall an many regions of India and country as whole but but did not lead a stage of excess deficite . From the above analysis we came on the second conclusion that rainfall in year 2020 was normal and was higher than year 2017 and 2018. Therefore we establish the fact that the methrological condition was in favor for famemers in 2020 in country as whole .

Analysis Based on comparison between land cover maps(2017,2018,2019,2020)

Introduction

From the previous section we found that Indian monsoon and rainfall in year 2020 was normal. We also saw the variation in the area under agriculture for both the the cropping session rabi and kharif with the help of Vegetation Index . However NDVI has few limitation one of which is to classify vegetation on the bases of plant type . hence to overcome this limitation as well as to study the change in agriculture area under different crops , we used , global land cover maps of India from 2017 to 2020 (ESA CCI Land Cover Website, n.d.).



Methodology

Land Cover Project is the part of the ESA Climate Change Initiative (CCI). This project is concerned with the generation of the land cover ECV. According to (Buchhorn et al., 2020) land cover is defined as the Physical property of the earth surface land covers include grass, asphalt, trees, bare ground, water, etc

The land cover maps which are generated are of 100 M resolution globally, with ellipsoid WGS 1984. The physical features of map is classified under 17 different category . However for our study we have used pixel containing following feature and rest were merged as other area . The features which we used Cropland, rainfed , cropland irrigated or post flooding , mosaic natural vegetation (tree ,shrub , herbaceous cover)(>50%)/cropland(<50%) only . Each feature was denoted by a unique serial number . Which helped us to eliminate the excess data.

In Second part of the analysis , we provided districts as well as their respective state wise Agriculture data .To maintain the authenticity of the data , this information was directly taken from the government of India's land use management website (Government of India, n.d.),(*Land Use Statistics Information System*, n.d.).This Information is available on the basis of

1)sessions- kharif , Rabi, Winter and Annually.

2)States and Districts

3) Year

4) Crop type

Agricultural year in India is divided in three major sessions Rabi , Kharif , Zadi (*Viswanath, 2005*).

For our analysis we studied the regarding area under Wheat , Rice (including Basmati) ,Pigeon pea (yellow pulses) , Sugarcane , Maze , Potato and other crop .Reason behind this selection is that these crop plays an important role in the staple diet of India(*Alae-Carew et al., 2019*) .Moreover Rice ,Wheat and Pulses are also covered in the National food security act of India (FAO.Org :, n.d.).

Our study period was From 2017 to 2020 . Here it is important to note that Due to administrative division of state of Jammu and Kashmir in year 2019 the GIS maps of 2019 and 2020 is different from the previous one (The Jammu and Kashmir Reorganisation Bill, 2019, n.d.)

The data of the crops were taken on the basis of their session of harvest .For the crops such as rice which grown twice a year annual data was taken . This was done to avoid any misrepresentation and overlapping of data.

The area under different crops is in hacts and the production in Tonnes . So, it was necessary to calculate the total area in under agriculture from land cover maps in hectares , and in order to do so the Coordinate system of the maps were changed to unprojected coordinate system WGS_1984. This Coordinate system is an Earth-cantered, Earth-fixed terrestrial reference system and geodetic

datum. It is based on a consistent set of constants and model parameters that describe the Earth's size, shape, and gravity and geomagnetic fields. WGS 84 is the standard U.S. Department of Defence definition of a global reference system for geospatial information and is the reference system for the Global Positioning System (GPS). It is compatible with the International Terrestrial Reference System (ITRS).(World Geodetic System 1984, n.d.).

The resolution of all maps obtain from ARC GIS was 1 km *1Km .In later part of the section we will see Crop maps. On the basis of these map we have calculated Green Water and blue water for year 2017 and 2020 for each crop for each district .

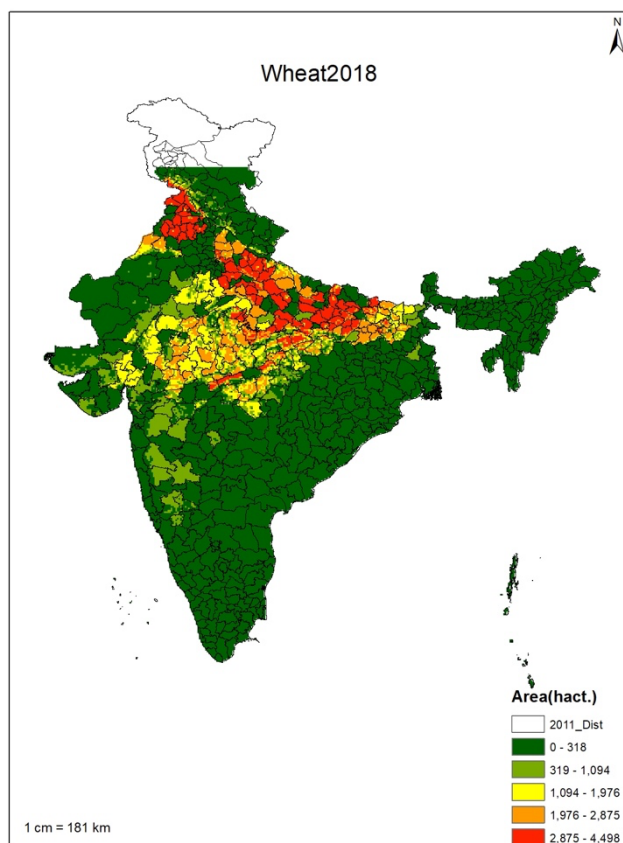
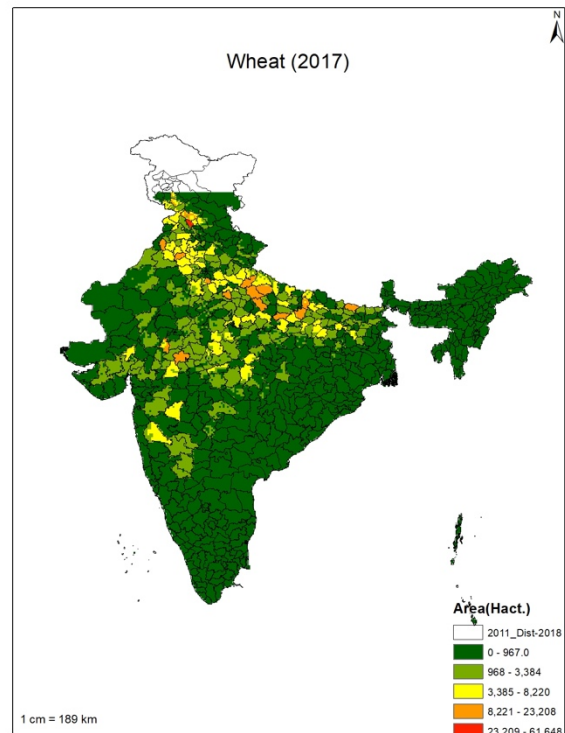
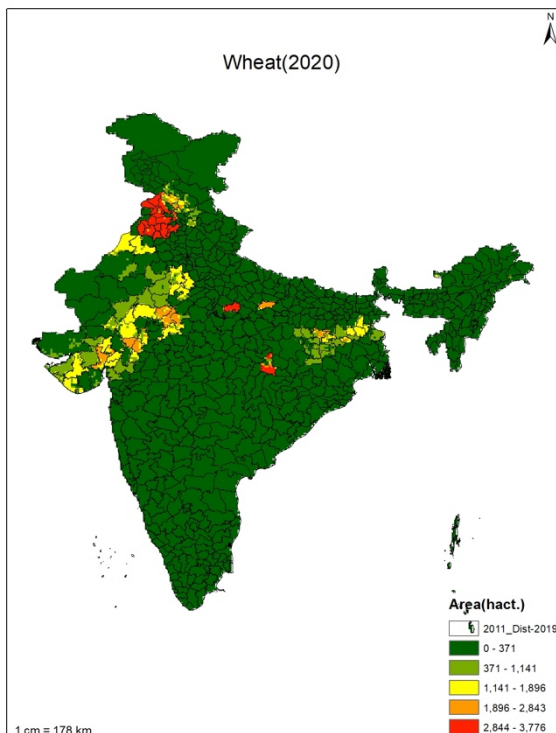


Figure xxxi Wheat Cultivation District wise

Wheat

These map were created on the basis of agriculture data for Wheat. From these we can see that Wheat production which covered the largest agricultural area in India in year 2018 . In year 2020 and 2018 Punjab the north western state of India was under intense farming of wheat . However this trend was not visible in year 2017 . In none of the three years wheat is grown in a large area in south of India. In 2018 wheat coverage area was very high in whole northern India .

Wheat is known for its high adaptability and climate resistance. Wheat is one of the few crops which can be grown from 7 to 60 degree latitude and even beyond. Wheat can tolerate high cold along with snow and still can resume its growth in the spring. There are 20 different varieties of wheat in India, and they are grown in different soil textures, such as clay loam or loam texture. Any soil with good structure and moderate water holding capacity are ideal for wheat cultivation.

Rice

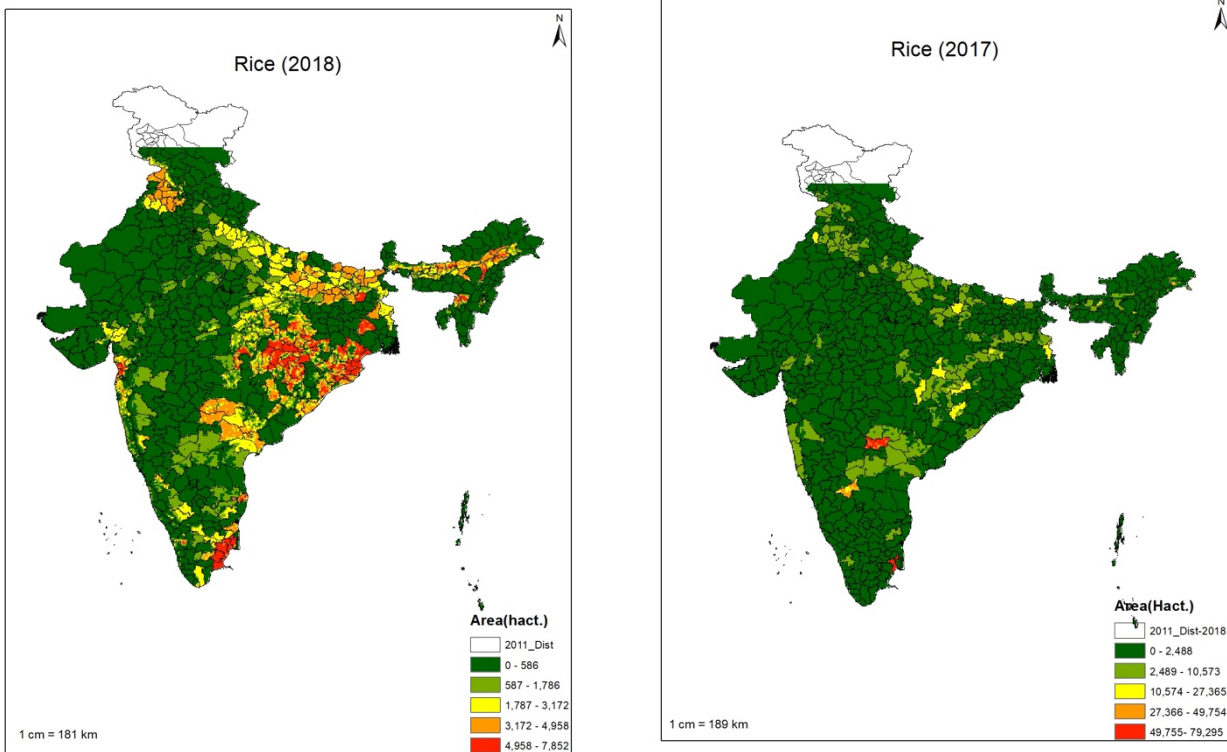
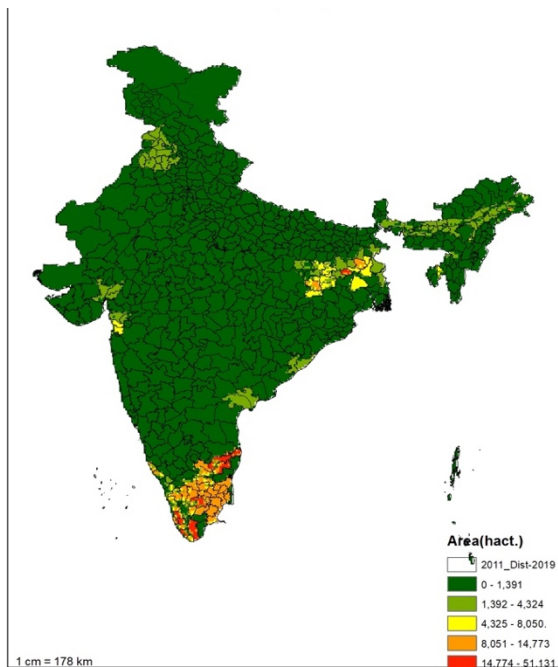


Figure xxxii Rice Cultivation District wise



From the agricultural data of 2017 ,2018 and 2020 of rice. we created these maps . we can observe that 2018 the coverage of rice was highest and it was going is large areas of south central and south eastern districts .However this trend was not visible in year 2020 . And only few districts of southernmost state of Tamil nandu was under rice cultivation of large area. In 2017 approx. only two districts were having very high coverage of Rice fields .

The average temperature required throughout the life period of the crop ranges from 21 to 37° C. Maximum temp which the crop can tolerate 40degreeC to 42degreeC.

Maze

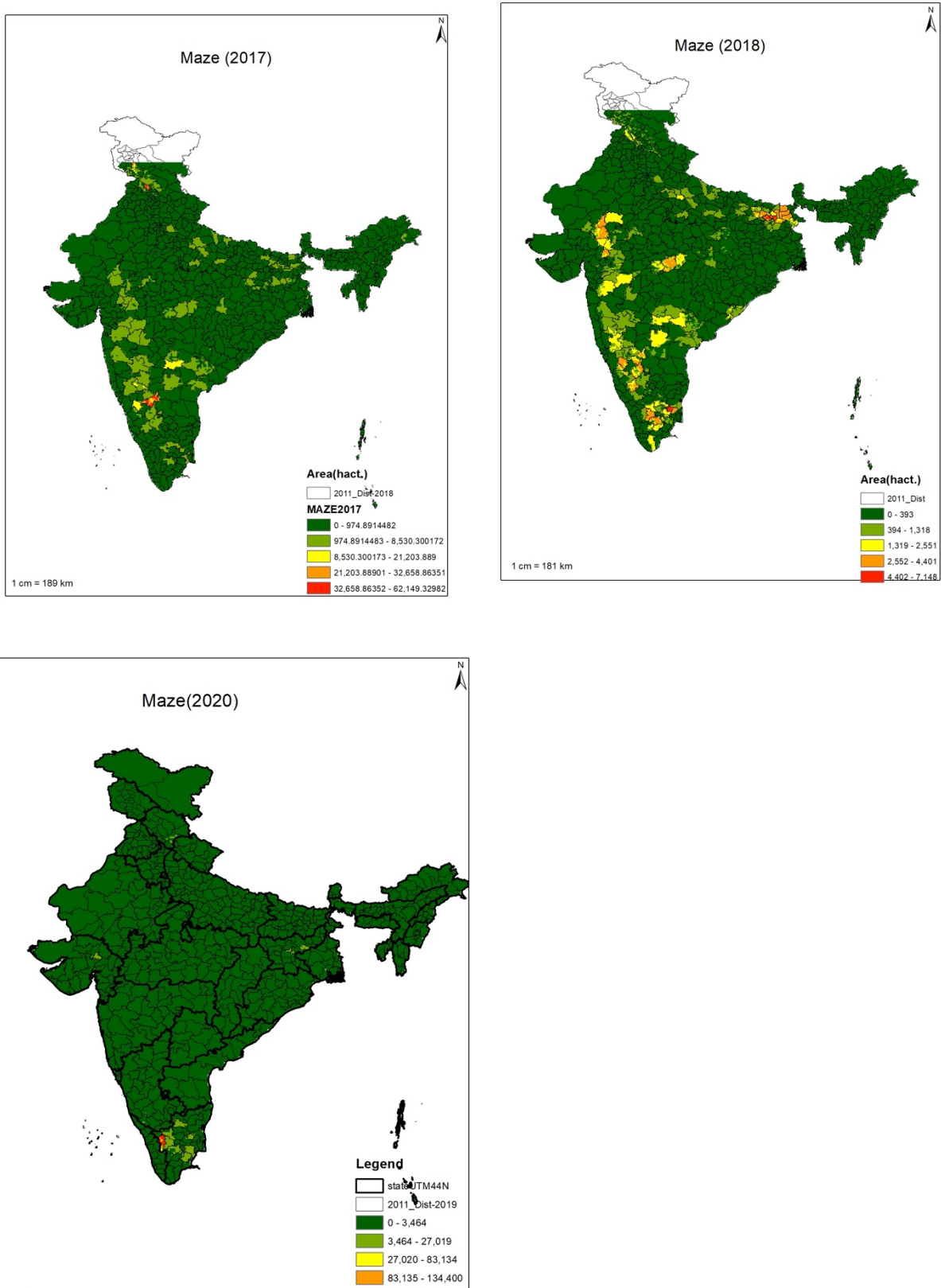


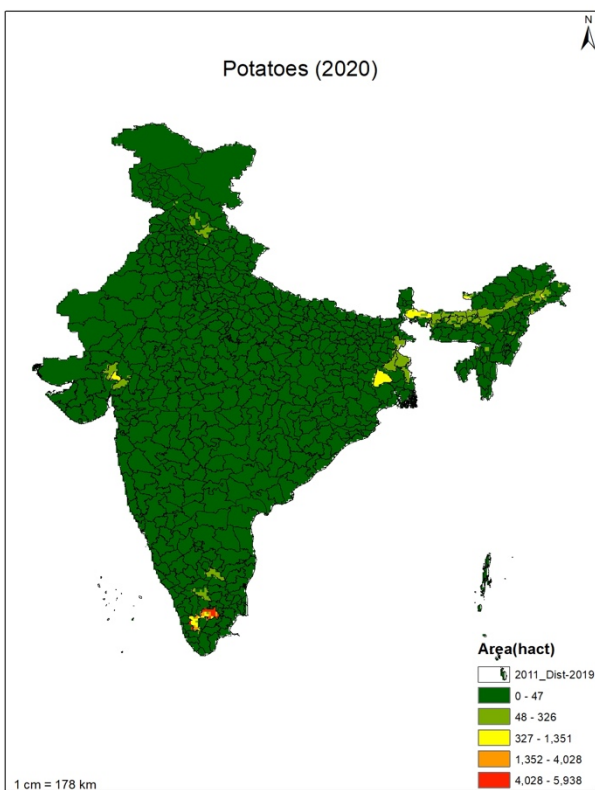
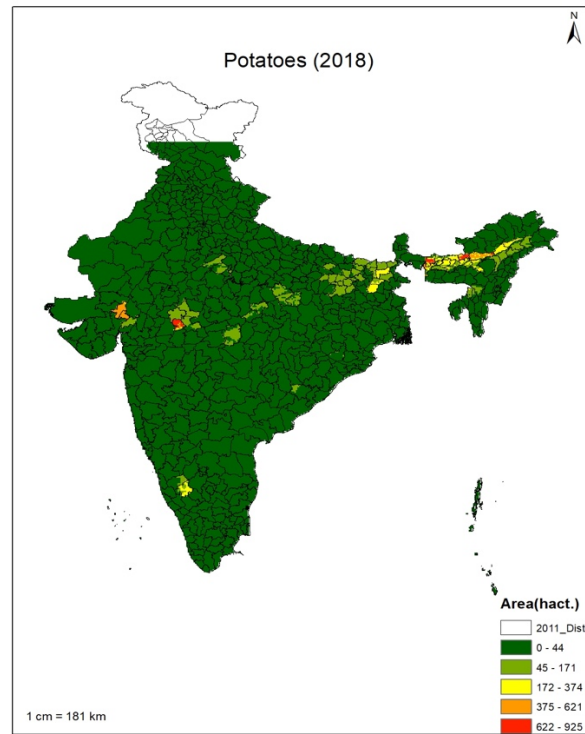
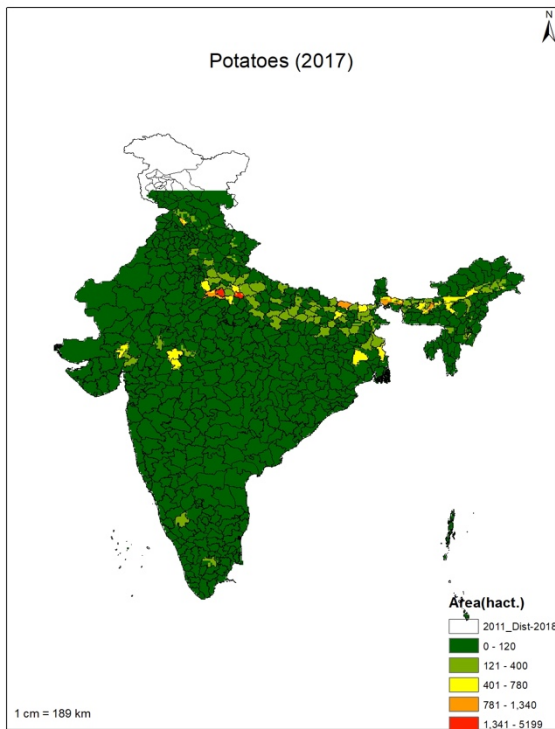
Figure xxxiii Maze Cultivation

Among the maize growing countries, India rank 4th in area and 7th in production, representing around 4% of the world maize area and 2% of total production in India (FAO.Org :, n.d.) .Maize is principally grown in two seasons, rainy (kharif) and winter (rabi). From our analysis we found that Kharif maize represents around 80% of maize area in India, while Rabi maize correspond to 20% maize area. It is important to note that a large quantity of the maize production in India, approximately 47%, is used as poultry feed. Of the rest of the produce, 13% is used as livestock feed and food purpose each, 12% for industrial purposes, 14% in starch industry, 7% as processed food, and 6% for export and other . purposes (*India Maize Scenario – ICAR-Indian Institute of Maize Research, n.d.*).

We found that in year 2020 the two total area under maize cultivation in India was 34000 Sq.KM, In which the highest area was in the district of Kodagu and Bellary state Karnataka .

In year 2017 the maize coverage was 72000 Sq.KM. Highest Maize grown area was in district of Jalgaon, state of Maharashtra . In year 2018 it was highest among three 81000 Sq.KM, district wise the largest area in maize was grown in Jalgaon

Potatoes



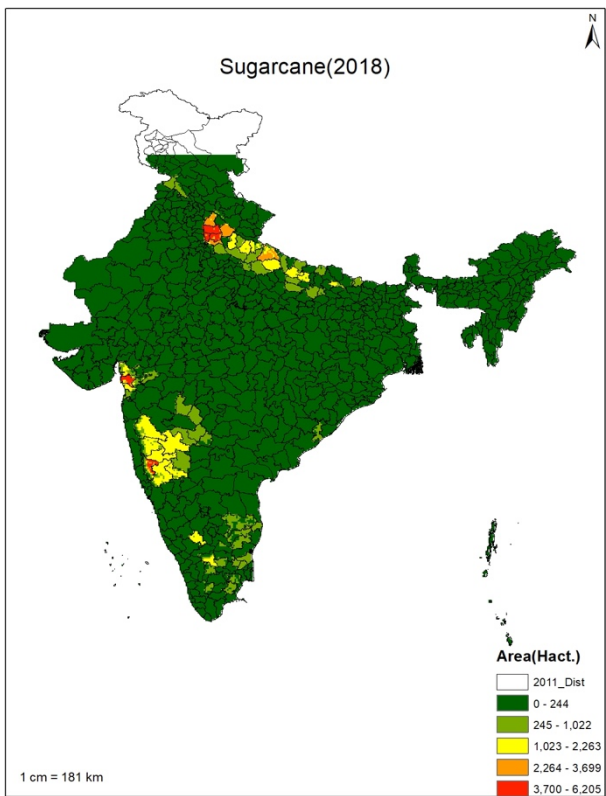
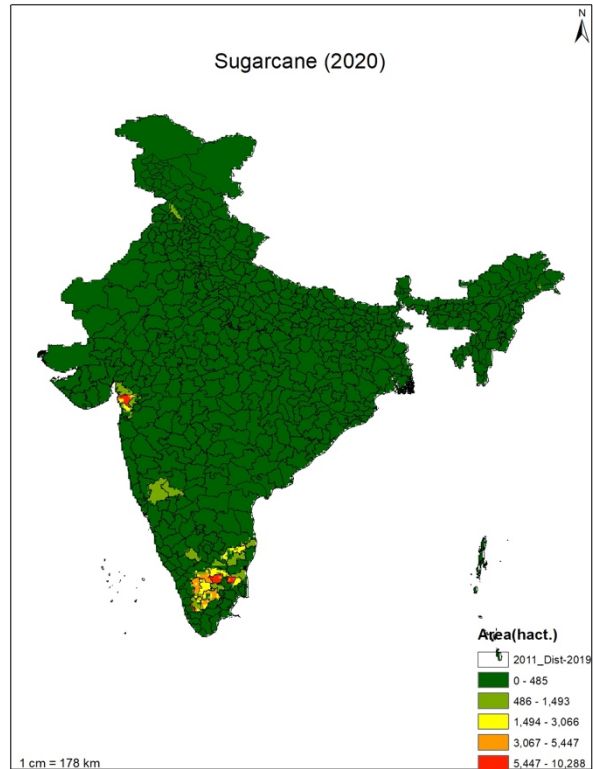
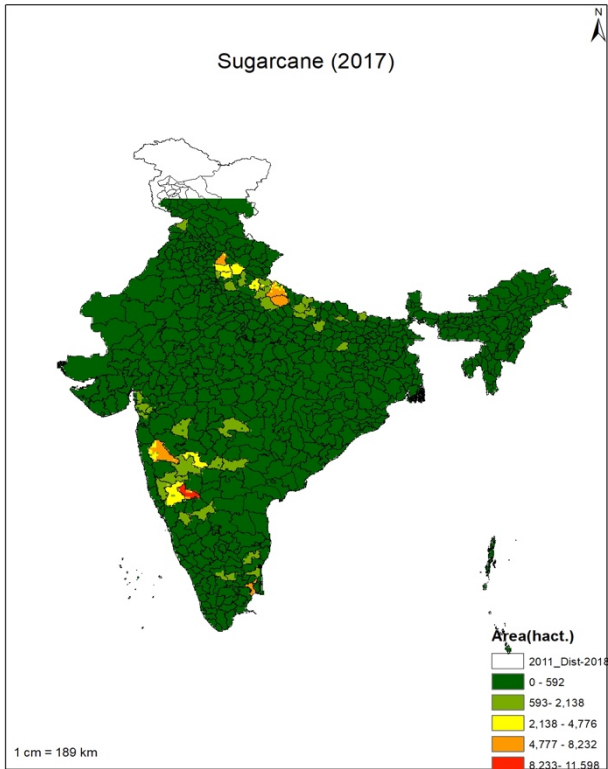
This map was created on the basis of the potatoes farms in India in year 2017,2018 and 2020. As in this map we can see that the eastern part of India and few districts of South India is under heavy potatoes farming . Similar trend can be seen in North-eastern states . Potatoes faming in central Indian states in not very significant . The potato can be grown almost on any type of soil except saline and alkaline soils. Naturally loose, offer least resistance due to which they help to the enlargement of the tubers. On the other hand loamy and sandy loam soils, rich in organic matter with drainage and aeration are highly suitable for crops .pH range of 5.2-6.4 is considered to be ideal. Potato are temperate

Figure xxxivPotatoes Cultivation

climate crop, however it grows under a diverse range of climatic conditions. It is grown only under such conditions where the temperature during the growing seasons is moderately cool. The vegetative growth of the plant is best at a temperature of 24°C while tuber development is favoured at 20°C. Due to diverse nature and usability potato is grown as a summer crop in the hills and as a winter crop in the tropical.

We also observe that maximum land holding under potato farm was least in the year 2018 and maximum in year 2020 .However the potatoes farming is dealing in compare with year 2017 to2020 .

Sugarcane



These maps were made on the bases of agricultural data for Sugarcane . From these maps it is visible that sugarcane was covering a larger area in year 2018 in compare with year 2020 and 2017 .However maximum area under sugarcane crop was less in 2018 that is 6205 hact in a district on the other in yea 2020 it was 10288 hact and 11598 hact in 2017 . western and southern part of India was growing sugarcane majorly in compare to the 2017 and 2018 .

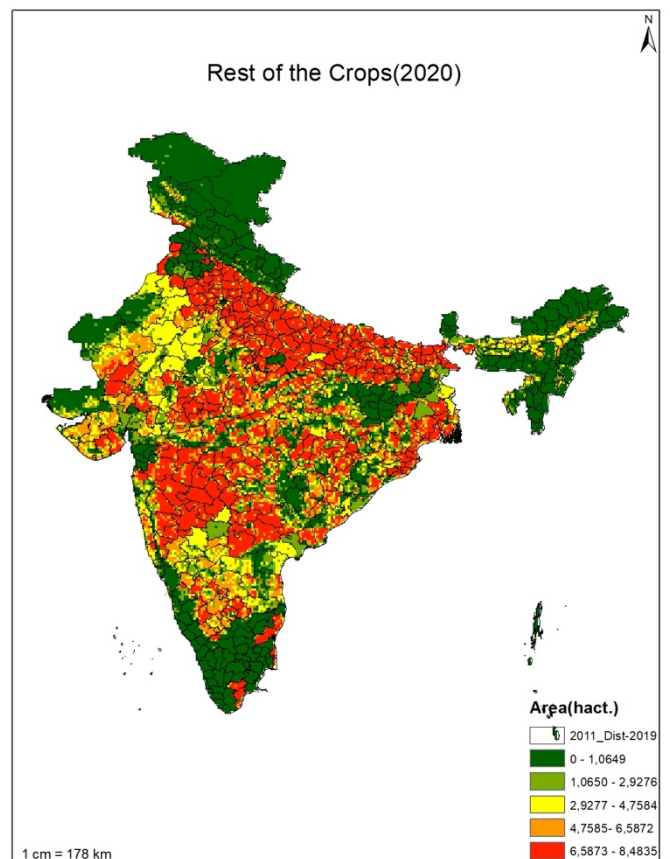
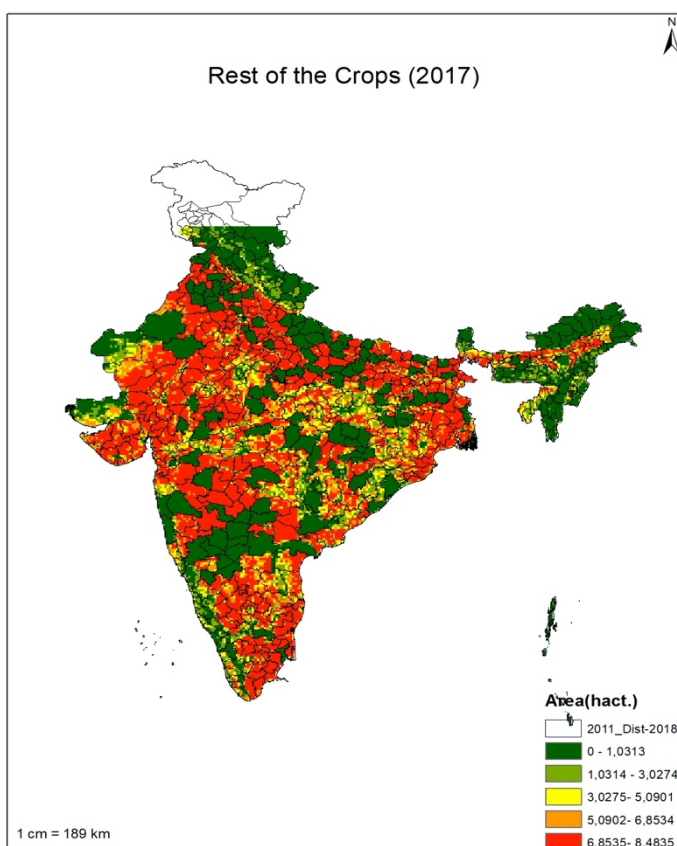
Sugarcanes can grow on different variety of soils due to which they are planted globally. Most favourable soil including loams, clayey loams, black cotton soils,

Figure xxxv Sugarcane Cultivation

brown or reddish loams and even laterites. In fact, sugarcane can tolerate any kind of soil that can retain moisture. But deep rich loamy soils are ideal for its growth. It is estimated that about 50 million farmers and their dependents are engaged in the cultivation of sugarcane and about 0.5 million skilled and unskilled workers are engaged in sugar factories and its allied industries

Other Crops

From Our analysis we found that in Year 2018 ,1.4 Million Sq.KM area was under agriculture cultivation it is important not that this area included area under net sown area not the area under repeated cultivation . this was done to avoided



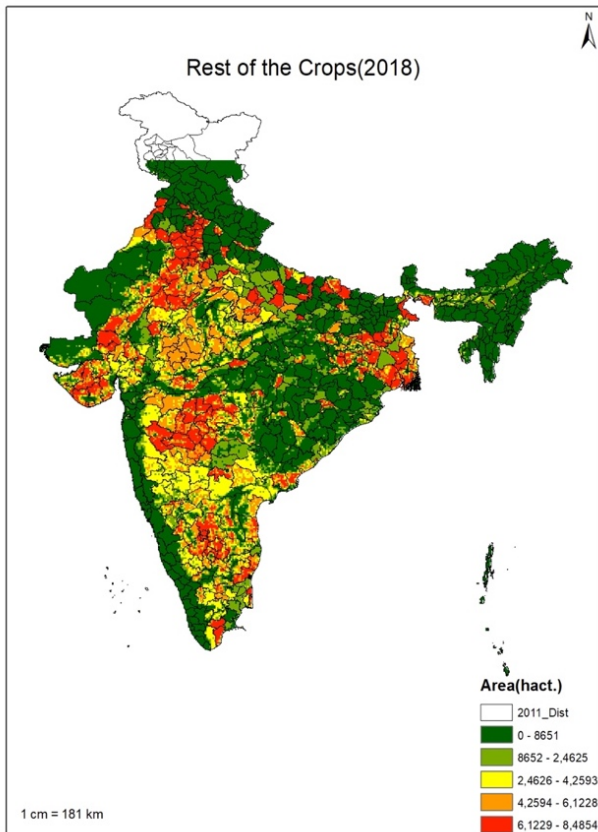


Figure xxxvi Other Crops cultivation

doubled representation of area which use for repeated farming in both session top 10 % area under cultivation belong to mostly north Indian states namely in Punjab and Madhya Pradesh .

In year 2017 0.5 Million Sq. Km area was under agriculture cultivation this is significantly less then 2018 however from the district wise analysis we can see that there was intense farming was followed by larger number of districts in compare to the subsequent year .

In 2020 the net area under cultivation was .2 Million Sq. km , was least among the three . In year 2020 intense farming can be seen in the whole northern eastern and southern central

part of India. In the north eastern state and valley of Brahmaputra which are famous for its tea were also under larger cultivation.

Pulses

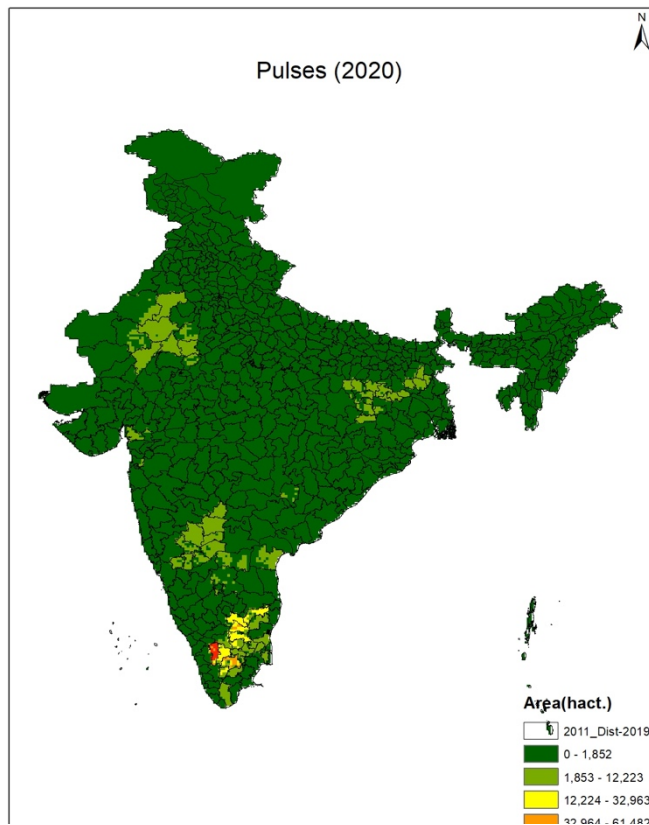
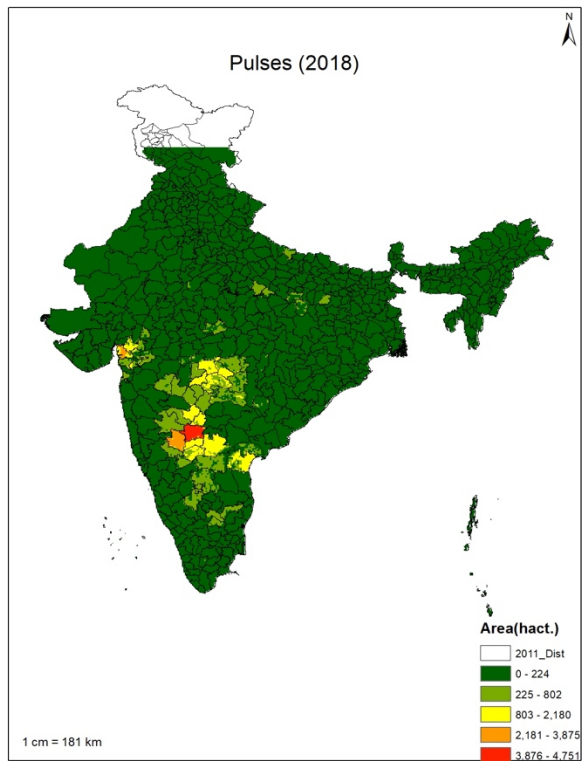
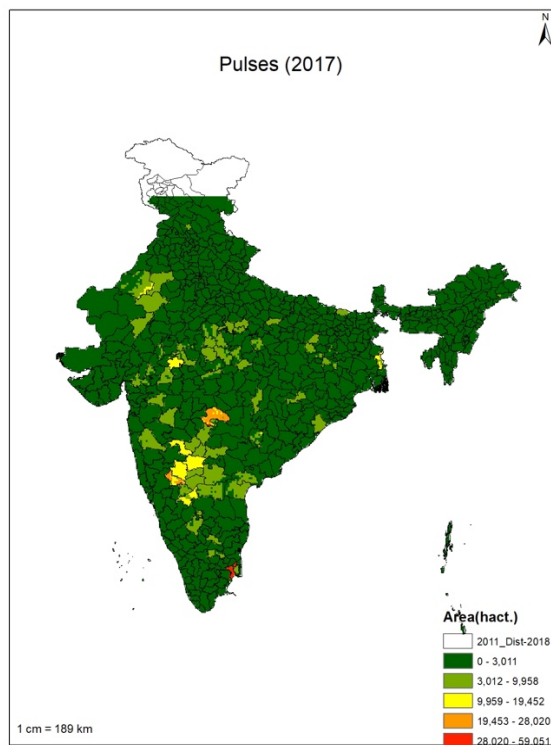


Figure xxxviiPulses Cultivation

FAO declared 10 Feb as the pulses day and 2016 as the year of Pulses (ref).Pulses are rich in protines which makes them highly desirable ,around the world . In India Pulses are given special imported because there high nutrition value , lower water requirement In India large amount of pulses are exported and imported. In India . Pulses contain 20 to 25 per cent protein by weight which is approximately double then double the

protein content of wheat and three times that of rice(*Pulses*, n.d.). *Major pulses are grown chickpeas* (gram), pigeon pea (tur or arhar), moong beans, urd (black matpe), masur (lentil), peas and various kinds of beans .The above map provide us information of all kind of pulses growing area in hact . We found that the total area under Pulses cultivation in year 2017 ,270000 Sq.KM however in 2020 this area was 140000 Sq.KM and 2018 it was highest among three 300000 Sq.KM. The Districts of Bikaner ,Nagur and Churu were the state with largest area under Pulses cultivation .

Water requirement and Water Scarcity)

According to a study done by (Taheripour et al., 2015) 60% of crops produced in India are irrigated and due to uneven monsoon, rise of commercial farming this demand is going to increase. Along with it if the demand for irrigation, when coupled with increases in industrial, residential, and commercial demands for water, the result is going to be an intense competition for water in India.

Increase or decrease in the agricultural area, can have significant impact on the water availability of that area. According to our analysis during the pandemic there was a reduction in the agricultural area overall. However, this reduction was not shown by all the states and districts of India and some showed the opposite. Therefore it was important to study the effect of changes in agricultural area on water prescience and how it affected the ongoing problem of water scarcity.

Methodology

The study was done in two parts, first, we calculated the green water and blue water, required, by each crop. This study was done on the basis of the GIS maps prepared and data of the previous part. To calculate green water and blue water we have used MATLAB.

On the basis of the crop water requirement, water scarcity was calculated by using our in-department simulation which is a MATLAB based script, that works on GIS maps for individual crop production. The crop categorisation was the same as the previous one - sugarcane, Rice (all varieties), Pulses (all varieties), Wheat, Potatoes, Maize and a rest of the crops.

Crop water requirement was calculated in m^3 per hectare for crop wise and district wise and Green water and blue water both were calculated separately.

Water scarcity is in the form of Number of months 0-12. For example if any district is having value 3 in the water scarcity analysis it means that state is suffering from water scarcity for 3 months out of 12 months of a year.

Terminology

Crop water Requirement - Crop water requirements (CWR) are defined as the depth of water [mm] needed to meet the water consumed through evapotranspiration (Etc.) by a disease-free crop, growing in large fields under non-restricting soil conditions including soil water and fertility, and achieving full production potential under the given growing environment (Pereira & Alves, 2013)

Green Water- water from precipitation that is stored in the root zone of the soil and evaporated, transpired or incorporated by plants. It is particularly relevant for agricultural, horticultural and forestry products. (Hoekstra, 2019)

Blue water -Water that has been sourced from surface or groundwater resources and is either evaporated, incorporated into a product or taken from one body of water and returned to another, or returned at a different time. Irrigated agriculture, industry and domestic water use . Water use in each of these process are known as Blue water (Fader et al., 2011)

Observation

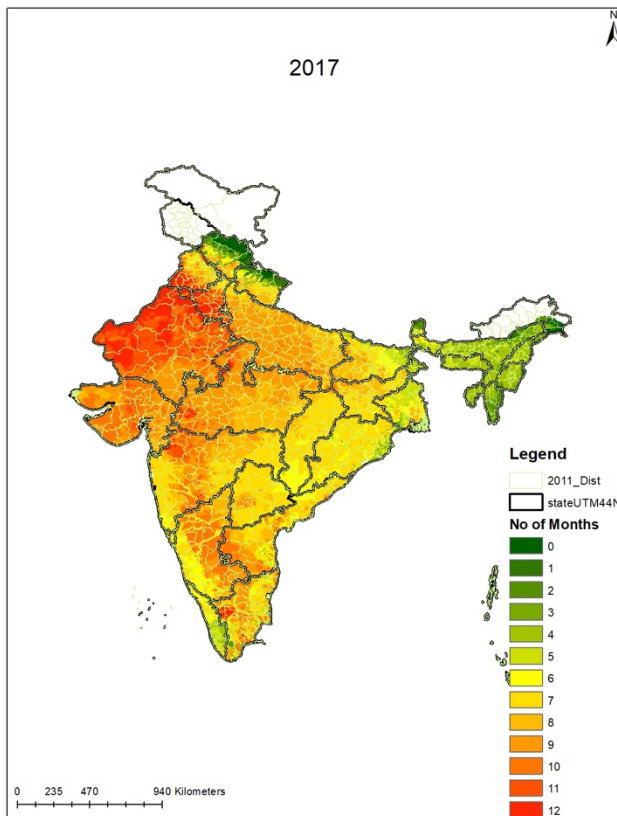


Figure xxxviii Water Scarcity 2017

-2017

From the our study of Metrology and precipitation data of India we were able. to make this conclusion that in year 2017 there was negative variation of rain in whole India . That year this trend was visible in all session . and the overall rainfall was normal than average . There was 112.7 cm of rainfall in the country and during SW Monsoon season, 95% of its normal rainfall which is 84.6cm was received.

From our analysis of water scarcity we found that a large number of Districts in northcentral and south west were under water scarcity for 7 to 9 months . Except for the

Himalayan district and districts lies in the foot hills of Burma rainforest all the districts were under water stress condition for more than 2 months . To understand the water stress condition better we classify the district on the babies of their respective states and we found that the state of Rajasthan Chandigarh and Delhi were under 10 month water scarcity .

the least was in Jammu Kashmir and Meghalaya

2018

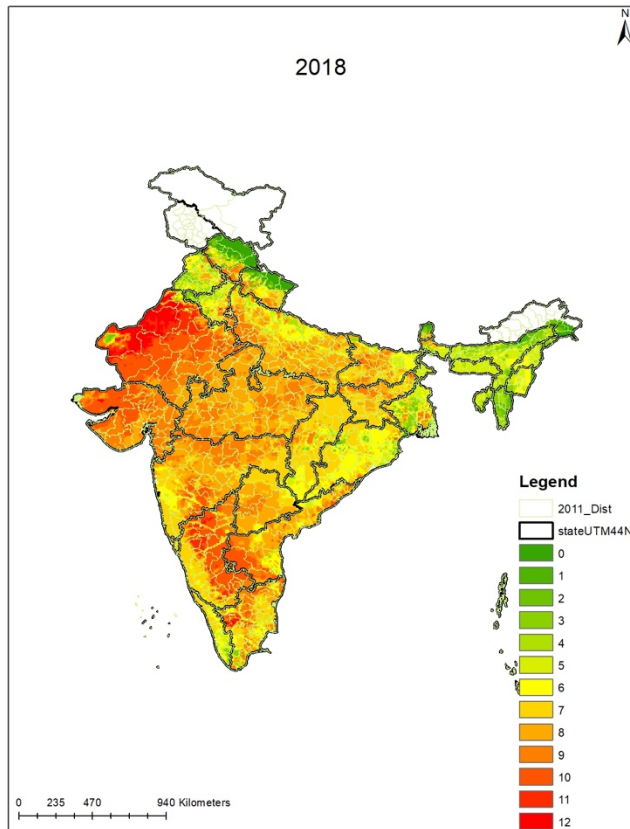


Figure xxxix Water scarcity 2018

In year 2018 India receive 102.08 cm rainfall which was 86% of its normal rainfall of 118.7 cm. On the other hand during Southwest monsoon season. India received 80.41 cm rainfall which was 91% of its normal rainfall of 89 cm

From our analysis we found that this negative departure of rainfall is visible on the water availability of districts. If see the map of 2018 water scarcity. Almost half of the 635 Indian Districts were water stress condition for 8 to 9 months of the year. 90% of these districts lies in the central and South central part of India .35 northern districts were under water stress

condition for 4 to 5 months which suggest higher rainfall then normal .Himalayan Districts of north India were under zero water stress condition for year 2018

2020

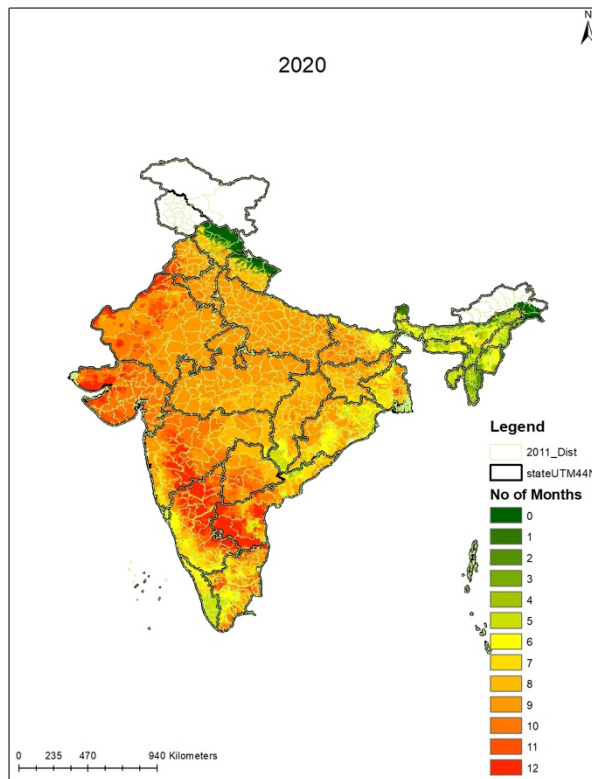


Figure xl Water scarcity 2020

According to the Rainfall statistics of year 2020, the annual rainfall received by the country was 110% (128.9cm) of its normal rainfall of 118.7 cm. Whereas All India rainfall for SW monsoon season 2020 was 109% (96.1 cm) . From the map we can see that three major agricultural states of India that is Uttar Pradesh , Madhya Pradesh and Rajasthan suffer from water stress condition for more than 8 months of the year . Whereas in south India we have a mixed result amongst states and there various districts . there are few costal and rainforest based districts which suffer water stress

condition only for 1 or 2 months . however major part of south central districts were facing unviability of water for 12 months .

Results

With the help of this analysis, districts which are facing high water scarcity . a For a better understanding of the situation we arranged the ddistricts accoutring to there respective state wised to an average .We found that in 2017 and 2020 there was water scarcity for 6 months in India on an average , however in 2018 this number was higher and there was 7 month water scarcity .In the Figure number of moths a state is facing water scarcity is shown for all the three years .In 2020 state of Rajasthan , Chandigarh and national capital region of new Delhi was facing 10 months of water scarcity.

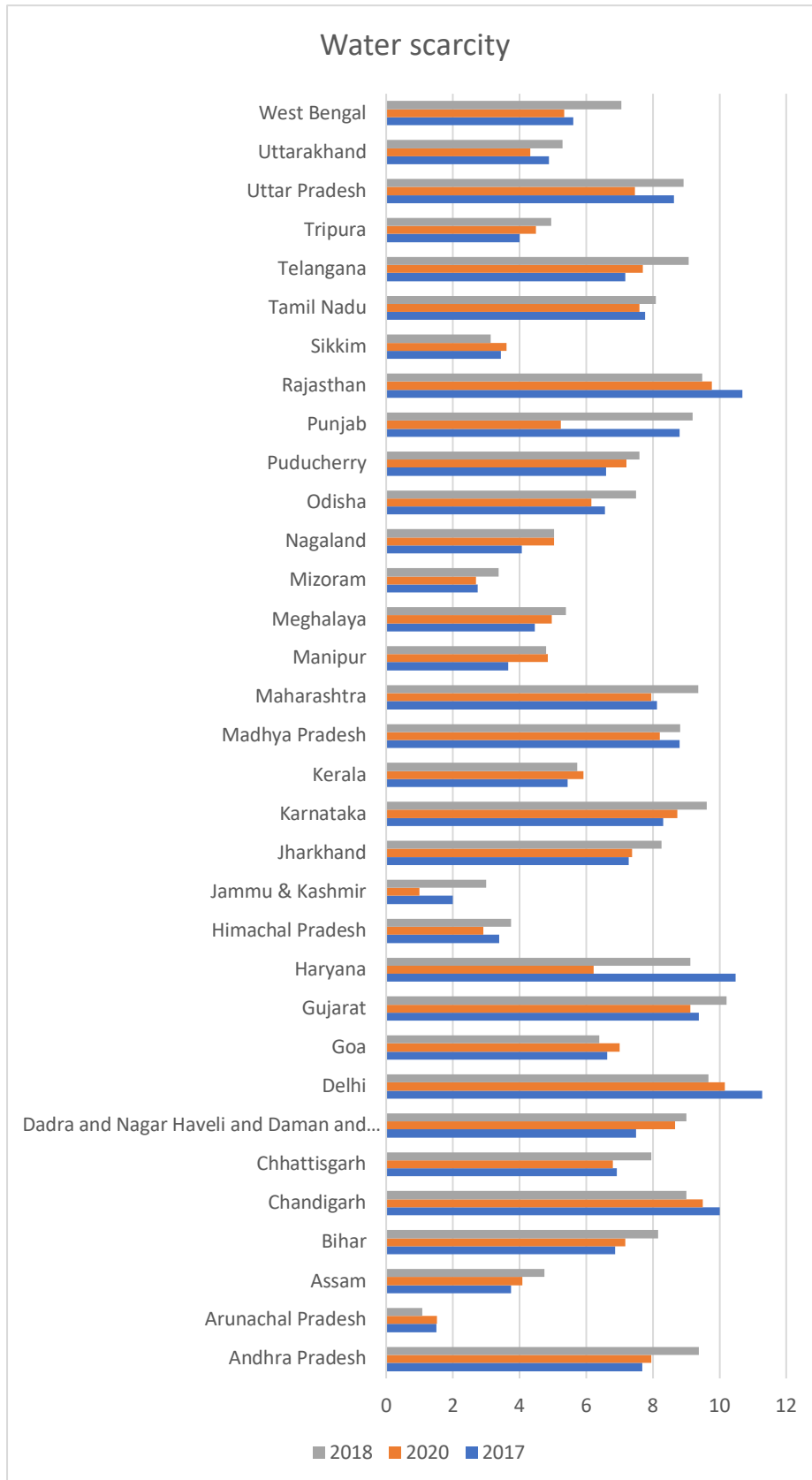


Figure xliStates suffering from Water scarcity 3 years comparison

Corelation analysis and comparative analysis

In above chapters we studies the impact which was caused by the covid 19 both directly and indirectly . Our aim was to study all the factors which effects the agriculture production in India. In this concluding section we made an attempt to find a corelation between different factor , which faction put the higher influence over other .

we also studied the changes in the percentage of the area under agriculture in kharif and rabi session and for this purpose we made comparative analysis of NDVI maps of 2020 and 2017 for 31st September (kharif) and 31 st jian (rabi) .

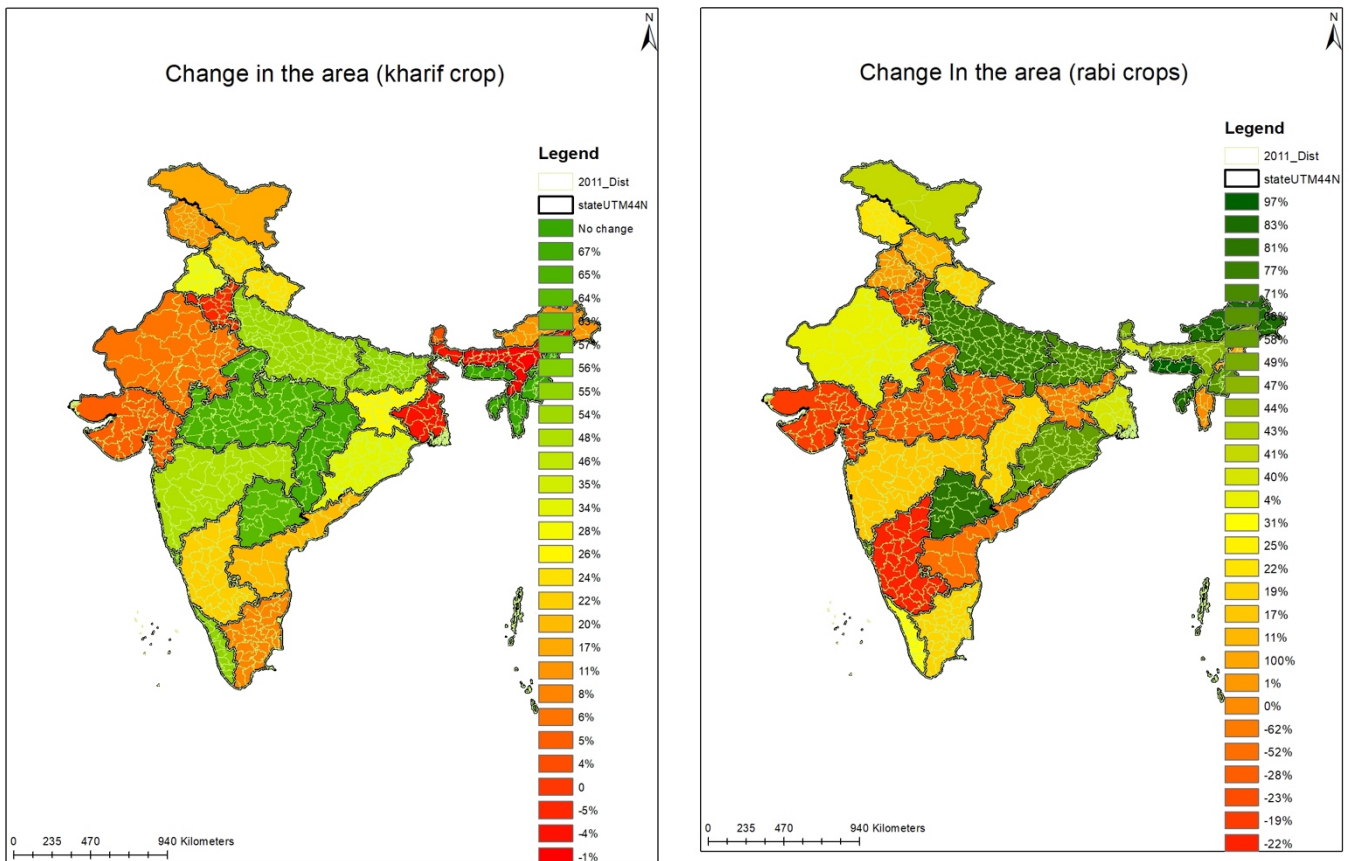


Figure xlii Change in the agricultural Area in Rabi and kharif (2020 - 2017)

Observation

Area under rabi crop was Increased in India by 27 % in average , whereas area under kharif crops was increased in by 20% . We se state wise in both session state Of Haiyan showed reduction the

area under crops . State of Punjab which showed increase in kharif area by 28 % showed a slower rate in rabi ,1% . State which are prominent for labour outward migration Uttar Pradesh , Bihar , Madhya Pradesh showed a steep rise in area under cultivation epically for kharif crops .Other the Madhya Pradesh both states

Factors	water scarcity	Kharif change	DensityofAgriculturelabourmigrant	Rabi change	Rice Production	Wheat Production
<i>water scarcity</i>	1.00					
<i>Kharif change(area)</i>	0.02	1.00				
<i>DensityofAgriculturelabour</i>	-0.15	-0.30	1.00			
<i>RabiChange (area)</i>	-0.31	0.47	-0.19	1.00		
<i>Rice Production</i>	0.35	-0.08	-0.10	-0.16	1.00	
<i>Wheat Production</i>	0.26	0.11	-0.10	-0.01	0.76	1.00

Figure xliiiCorrelation analysis

maintained the trend of rise in area under agriculture in rabi session too

From the corelation analysis of 2017 with 2020 , data we found that the production of wheat and rice is negatively related to the number of migrant workers working in the field , which means that higher the number lower is the production which is justified due to less use of modern machinery . However If we look at the area under cultivation we found that there is slight positive relation with water scarcity in kharif reason . It an happen due to a weaker monsoon in 2018 which can lead to intensive cultivation in 2020 .Water scarcity is highly influenced bythe production of Rice and wheat , if we have a higher production we have higher water scarcity .

Way forward and suggestion

In this thesis we saw how the covid -19 changed the lifestyle of consumer and farmers . The large migration from agriculture state northwest state led to a reduction in production of wheat and rice by 10 % . The farmers who went back to their home state had to start farming , which was viable in. Satellite images and NDVI however this increase was not transferred in Production capacity .One of the reasons which can cause this trend is the lack of modern agriculture machinery which was available for labours in agricultural states.

Another result what we found is that the COVID -19 's spread was not entirely density dependent , we found that there were many districts with high population and low covid cases .

From this report we suggest government following points-

- More robust mechanism for future pandemics
- Introduction of modern Agricultural Machinery in the North eastern states , so that intense farming can be done in those states to where outward migration is going on
- A proper updated registry need to maintain relation the location of labour and their skills should be maintained too.
- The increase in consumption of food grain by the population covered in NFSA and other PDS schemes was noted , which is a positive sign however the additional food allotment sanctioned in 2020 should continue .
- Crop diversification need of hour now , states such as Punjab ,Delhi and nearby regions are now facing year long water scarcity .

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