

Evaluation of Contemporary Agricultural and Geo-environmental Change by The Thought of Von Thünen Model of Agricultural Land Use In India

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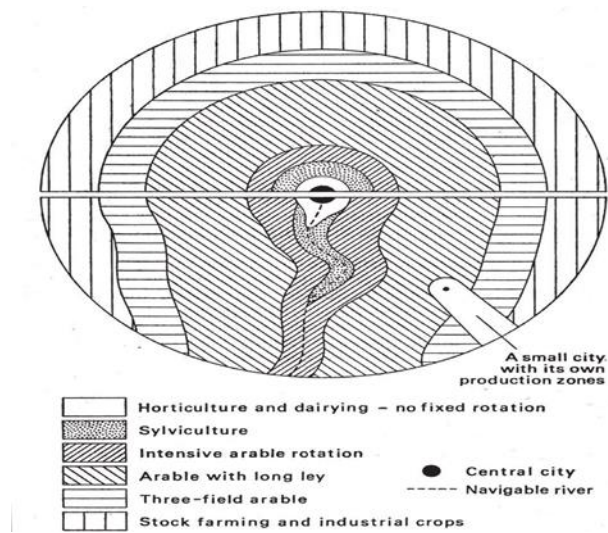
Abstract

Contemporary agricultural and geo-environmental change by the thought of von Thünen model of agricultural land use in india , **Agarwal, Kabir (9 March 2021)**, create more sustainable agricultural production models. While the applicability of the classic von Thünen model appears, at times, relevant for different In the contexts, this present paper represents in general, and particularly for highly industrial economies, modifications of the classical model have **Von Thünen, J. H. (1966)** become the norm changing aspect of trend f agricultural land use in india. The term “agricultural revolution” refers to major agricultural changes brought about by innovations, discoveries, or new technology—agricultural revolutions in India altered industrial methods and enhanced output rates. Several agricultural revolutions in India signalled the start of an entirely new age in agriculture. **Clark, C. (1976)**, Indian agriculture grew enormously as a result of the agricultural revolutions in India, which opened up new prospects.

Keywords: Agricultural Land Use, Von Thünen Model, Green Revolution, Sustainable Agriculture, Land Reforms

INTRODUCTION:

The agricultural location theory is a normative economic model which was first presented in 1826 in a book called *Der Isolierate Stat.* **Deshpande, Tanvi (2021)** This theory is based on the concept of Economic Rent which is prevalent in farm market distance relationship. The agricultural location theory is one of the earliest attempts to explain the pattern of land use in economic terms which **Clark, C. (1976)** , was proposed by Von Thunen. Agriculture plays a vital role in India's economy. 54.6% of the total workforce is engaged in agricultural and allied sector activities (Census 2011) and accounts for 17.8% of the country's Gross Value Added (GVA) for the year 2019-20 (at current prices). Given the importance of the agriculture sector, Government of India has taken several steps for its development in a sustainable manner. **Von Thünen, J. H. (1966)** Steps have been taken to improve the income of farmers. Further, to mitigate risk in the agriculture sector, a scheme “Pradhan Mantri Fasal Bima Yojana” (PMFBY) was also launched in 2016. Schemes such as Formation & promotion of 10,000 FPOs & the Agriculture Infrastructure Fund have also been launched recently to benefit the sector. Von Thunen theory of agricultural location predominantly concerned with the agriculture, types of agriculture and prosperity of an urban market. He devised this theory by calculating the relevant data of last five years of Mecklenburg. Above all, the main aim of Von Thunen's model on agricultural location was to show how and why **Anburaja, V. and Nandagopalan, V. (2012)**, agricultural land use varies with the distance from the market.



Anburaja, V. and Nandagopalan, V. (2012) , Based on the value of production of varied agricultural produce, yields, cost of transportation and market prices, he demarcated six concentric zones with different agricultural production. **K. V. Subrahmanyam; T. M. Gajanana (2000)** , Indian farmers are people who grow crops as a profession. Various government estimates (Census, Agricultural Census, National Sample Survey assessments, and Periodic Labour Force Surveys) give a different number of farmers in the country ranging from 37 million to 118 million as per the different definitions.^[11] Some definitions take in to account the number of holdings as compared to the number of farmers.^[11] Other definitions take into account possession of land, while others try to delink land ownership from the definition of a farmer. Other terms also used include 'cultivator'.

OBJECTIVE:

1. To know the present relevance of von-thunen model in agricultural land use in contemporary economy
2. To know the recent trend of agricultural production by change of agro-based land use in india

RESEARCH QUESTION

1. What is the present relevance of von-thunen model in agricultural land use in contemporary economy?

2. What is the recent trend of agricultural production by change of agro-based land use in india ?

HYPOTHESIS :

H₀₁ there is no relationship between relevance of von-thunen model and agricultural land use in contemporary economy in india

H₀₂ there is no relationship between recent trend of agricultural production and agro-based land use in india .

POPULATION AND SAMPLE OF STUDY :

12 states has been taken for data interpretation and analysis as a sample . physically and geographically india has been considered as a population of study .

ANALYSIS AND INTERPRETATION :

India's National Policy For Farmers 2007 Defines Farmer As:

Anburaja, V. and Nandagopalan, V. (2012) , For the develop this Policy, the term “FARMER” will refer to a person actively engaged in the economic and/or livelihood activity of growing crops and producing other primary agricultural commodities and will include all agricultural operational holders, cultivators, agricultural labourers, sharecroppers, tenants, poultry and livestock rearers, fishers, beekeepers, gardeners, pastoralists, non-corporate planters and planting labourers, as well as persons engaged in various farming related occupations such as sericulture, vermiculture, and agro-forestry. The term will also include tribal families / persons engaged in shifting cultivation and in the collection, use and sale of timber and non-timber forest produce.



VON THÜNEN'S MODEL AND ASSUMPTIONS :

Created before industrialization, Von Thünen's key assumptions in the classical model are:

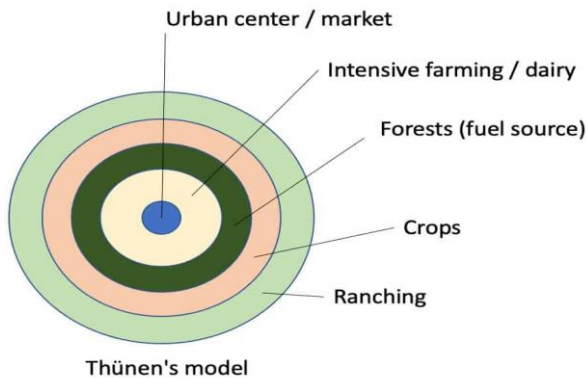
- 1) a city is centrally located in an “isolated state,”
- 2) one of the surrounding areas around a town is wilderness,
- 3) land is generally flat,
- 4) soil quality and climate are consistent,
- 5) farmers transport goods to a market using mainly carts, and
- 6) farmers behave rationally in choosing where to conduct their activities.

land use intensification does appear to have a relationship in countries where agriculture and grazing play a prominent role in the economy. Other forestry models have also found applicability of von Thünen's ideas in balancing land management and determining economic benefit from forestry, where rental income can be combined with ecosystem service models to create more sustainable forestry production models.

Clark, C. (1976) , While the applicability of the classic von Thünen model appears, at times, relevant for different contexts, in general, and particularly for highly industrial economies, modifications of the classical model have become the norm. This includes the use of multivariate and multi-scale approaches that also incorporate varied topography rather than pure flat regions. Such approaches account for varied economic use as well as connectivity of towns with the wider regional and global economy. Heterogeneous agents affecting land use practices and events, while hierarchical formation and development of urban systems,

have become key focus areas today for spatial economists in helping to explain urban and landscape dynamics.

Interestingly, von Thünen's classical land use model has applicability to different contexts found today. While that is the case, there are also multiple limitations to von Thünen's ideas that modern land use economic models attempt to address. The longevity of the model, and the fact it is often still used as a basis of analysis, does make it not only the first true spatial economic model but it continues to inspire researchers to develop methods that address its limitations. **Agarwal, Kabir (2021).**



VON THÜNEN MODEL DEFINITION :

Anburaja, V. and Nandagopalan, V. (2012) , The Von Thünen Model uses a simple equation to predict what land use is going to occur at any given point in space:

In the equation, R is the land rent (or locational rent); Y is the agricultural yield; p is the market price of a product; c is how much it costs to produce; F is how much it costs to get the product to market; and m is the distance to market.

This means that at any point in space, land rent (the money made by the landowner, who rents to the farmer) will be how much a product is worth once you subtract the cost to produce it and ship it to market.

Agarwal, Kabir (9 March 2021), Therefore, whatever costs the farmer the most will be located closest to the market, and whatever costs the least will be farthest away. For the person who owns the land that the farmer rents from, this means that the cost to rent the land will be the highest closest to the market town and drop as you move away.

The Von Thünen Model is closely related to bid-rent models in urban geography. Understanding how the Von Thünen Model can be adapted to modern rural landscape analysis and urban settings is crucial for AP Human Geography. For additional in-depth explanations, see our Land Costs and Bid-Rent Theory and Bid-Rent Theory and Urban Structure.

VON THUNEN THEORY OF AGRICULTURAL LOCATION:

Postulates of Von Thunen Model **At the centre of the agricultural region, there is an isolated state** having no connection with the world outside.

- The agricultural region has a city in its core and agricultural hinterland around that city.
- Physiographically, the agricultural location was homogeneous (in terms of relief, soil and climate).
- The cost of transportation and distance covered are directly proportional to each other.
- The surplus crop must be sold only in the market.
- There was only one mode of land transportation (horse and cart).
- The farmers of the agricultural hinterland were supposed to be optimizer (a rational and an economic man).
- Von Thunen also presumed that each farmer has complete information about agriculture. Due to their agricultural knowledge, they make rational decisions to increase their profit.

Economic rent

Anburaja, V. and Nandagopalan, V. (2012) , Economic rent is defined as the net income accruing to an area of land above the net income of land at the economic margin of production. The economic rent of a crop increases if the location of agricultural land is near the market due to less transportation cost. Von Thunen's concept of economic rent is also known as locational rent since the economic rent is estimated by the location of agricultural land.

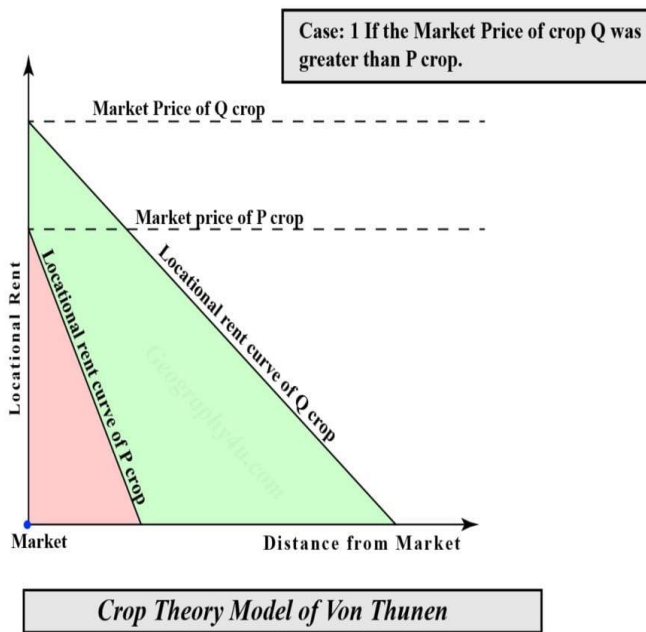
Models of Von Thunen theory of agricultural location

Intensity Theory

Due to the rise in transportation cost, intensive cultivation is most suitable near the city centre. Therefore, the intensity of production of a particular crop declines with distance from the market.

CROP THEORY :

Poulopoulos, S., and V. Inglezakis, eds.(2016) , According to crop theory, there will be a variation in the land use with distance and the factors responsible for the variation in the land use pattern are market price of a particular crop, transportation cost, production cost and yield per unit of land. The crop theory of Von Thunen can be understood by taking the following two cases.



Case- 1

Sinha, R.K. (2010) , When two crops P and Q have the same production cost and yield but having different transport cost and market price. If P is costlier to transport and has a higher market price then crop P will be grown closer to the market than Q. Due to higher transportation cost of crop P, the location rent of P decreases more rapidly.

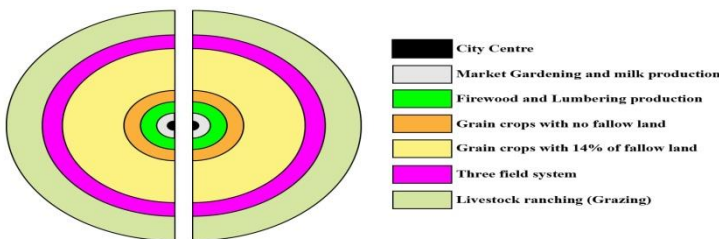
Case- 2

Agarwal, Kabir (9 March 2021), When two crops X and Y have the same production and transportation cost (per tonne/km) but different market price and yield per unit of land. If X has a higher yield and lower market price than Y, it will be grown closer to the market than Y.

CONCENTRIC ZONAL RINGS OF AGRICULTURAL PRODUCTION :

Zone-1: Market Gardening and milk production

Anburaja, V. and Nandagopalan, V. (2012) , The zone-1 would be dedicated to cash cropping. Due to deficiency of food preservation facilities, primitive modes of transportation and highly perish nature of products, market gardening and milk production were most suitable in this zone.



Von Thunen's System of Agricultural Landuse

Zone-2: Firewood and Lumbering production

Agarwal, Kabir (9 March 2021), The second zone was marked by the production of firewood. Due to heavy bulkiness and primitive transportation modes, wood was comparatively costly to be shipped. It was also

used as a fuel and building material. However, the outer limit of this zone was marked by wood which was highly in demand in the market.

Zone-3: Grain crops with no fallow land

Unlike zone-2, the zone-3 was marked by food grains. Rye was the most important market product of this zone, having no fallow land. The cropping intensity of this zone was highest as compared to zone-4 and

zone-5. Most importantly, grains could be stored, easy to transport and last longer than milk products. Also, the agricultural land would be cheaper farther away from the market.

Zone-4: Grain crops with 14% of fallow land

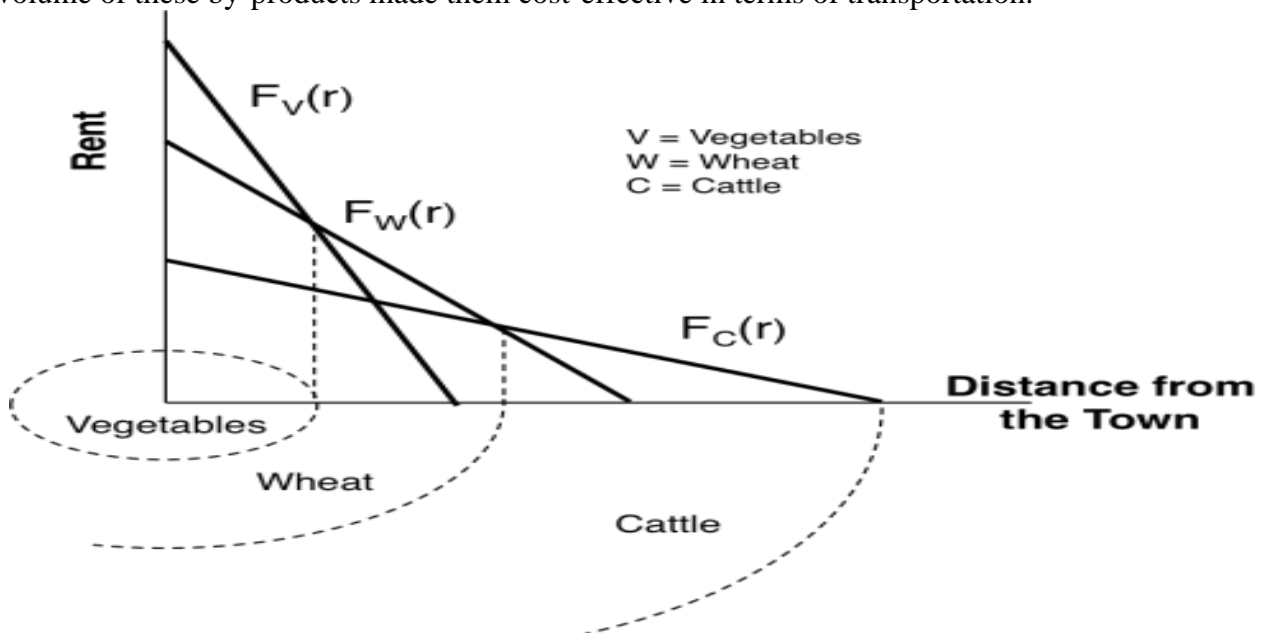
Deshpande, Tanvi (2021) This zone was marked by 14% of fallow land, having less crop intensity as compared to zone-3. The farmers of this zone usually practised seven years crop rotation with one year each rotation of rye, barley and oats, three-year rotation of pastures and one year as fallow land.

Zone-5: Three field system

Like zone-2, this zone was marked by extensive cultivation having 33% of land as fallow. The farmers of this zone practised three-field system, having 1/3rd of land as crop field, 1/3rd as pastures and rest left for fallow land.

Zone-6: Livestock ranching (Grazing)

Agarwal, Kabir (9 March 2021), The market products of this zone would be of two types namely, livestock and by-products of milk like cheese, butter, etc. which would not highly perishable. Also, the reduction in the volume of these by-products made them cost-effective in terms of transportation.



INDIAN AGRICULTURE AFTER INDEPENDENCE

Despite some stagnation during the later modern era the independent Republic of India was able to develop a comprehensive agricultural programme. blueberry flower harvesting in India. This is a cash crop in Central Gujarat, India.

Agarwal, Kabir (9 March 2021), In the years since its independence, India has made immense progress towards food security. Indian population has tripled, and food-grain production more than quadrupled. There has been a substantial increase in available food-grain per capita.

The state of Punjab led India's Green Revolution and earned the distinction of being the country's bread basket.^[53]

Clark, C. (1976) , Before the mid-1960s, India relied on imports and food aid to meet domestic requirements. However, two years of severe drought in 1965 and 1966 convinced India to reform its agricultural policy and that it could not rely on foreign aid and imports for food security. India adopted significant policy reforms focused on the goal of food grain self-sufficiency. This ushered in India's Green Revolution. **Sinha, R.K. (2010)** , It began with the decision to adopt superior yielding, disease resistant wheat varieties in combination with better farming knowledge to improve productivity. The state of Punjab led India's green revolution and earned the distinction of being the country's breadbasket.



Agarwal, Kabir (9 March 2021), The initial increase in production was centred on the irrigated areas of the states of Punjab, Haryana and western Uttar Pradesh. With the farmers and the government officials focusing on farm productivity and knowledge transfer, India's total food grain production soared. A hectare of Indian wheat farm that produced an average of 0.8 tonnes in 1948, produced 4.7 tonnes of wheat in 1975 from the same land. Such rapid growth in farm productivity enabled India to become self-sufficient by the 1970s. It also empowered the smallholder farmers to seek further means to increase food staples produced per hectare. By 2000, Indian farms were adopting wheat varieties capable of yielding 6 tonnes of wheat per hectare.

Anburaja, V. and Nandagopalan, V. (2012), With agricultural policy success in wheat, India's Green Revolution technology spread to rice. However, since irrigation infrastructure was very poor, Indian farmers innovated with tube-wells, to harvest ground water. When gains from the new technology reached their limits in the states of initial adoption, the technology spread in the 1970s and 1980s to the states of eastern India — Bihar, Odisha and West Bengal. The lasting benefits of the improved seeds and new technology extended principally to the irrigated areas which account for about one-third of the harvested crop area. In the 1980s, Indian agriculture policy shifted to "evolution of a production pattern in line with the demand pattern" leading to a shift in emphasis to other agricultural commodities like oilseed, fruit and vegetables. Farmers began adopting improved methods and technologies in dairying, fisheries and livestock, and meeting the diversified food needs of a growing population.

As with rice, the lasting benefits of improved seeds and improved farming technologies now largely depends on whether India develops infrastructure such as irrigation network, flood control systems, reliable electricity production capacity, all-season rural and urban highways, cold storage to prevent spoilage, modern retail, and competitive buyers of produce from Indian farmers. This is increasingly the focus of Indian agriculture policy.



K. V. Subrahmanyam; T. M. Gajanana (2000), India ranks 74 out of 113 major countries in terms of food security index. India's agricultural economy is undergoing structural changes. Between 1970 and 2011, the GDP share of agriculture has fallen from 43% to 16%. This isn't because of reduced

importance of agriculture or a consequence of agricultural policy; rather, it is largely due to the rapid economic growth in services, industrial output, and non-agricultural sectors in India between 2000 and 2010.

CHANGE OF LAND USE MODEL AND IMPACT OF PRODUCTION :

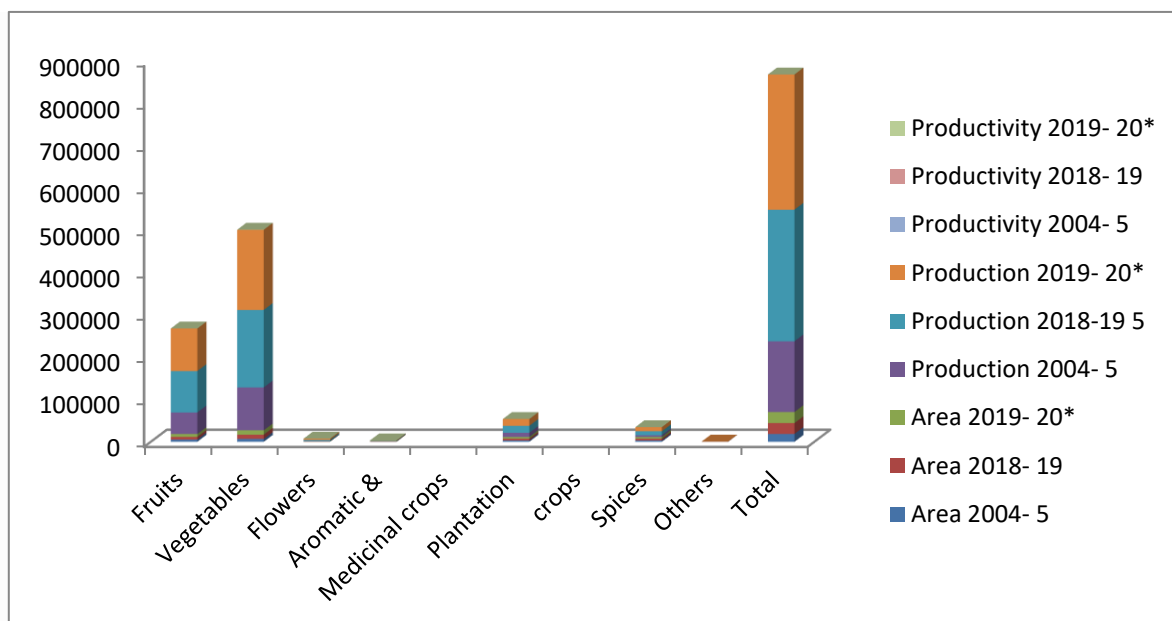


- **Poulopoulos, S., and V. Inglezakis, eds.(2016) ,** Source of livelihood: Agriculture is the main occupation. It provides employment to nearly 61% persons of total population. It contributes 25% to national income.

- Dependence on monsoon: Agriculture in India mainly depends on monsoon. If monsoon is good, the production will **Clark, C. (1976) ,** be more and if monsoon is less than average then the crops fail.

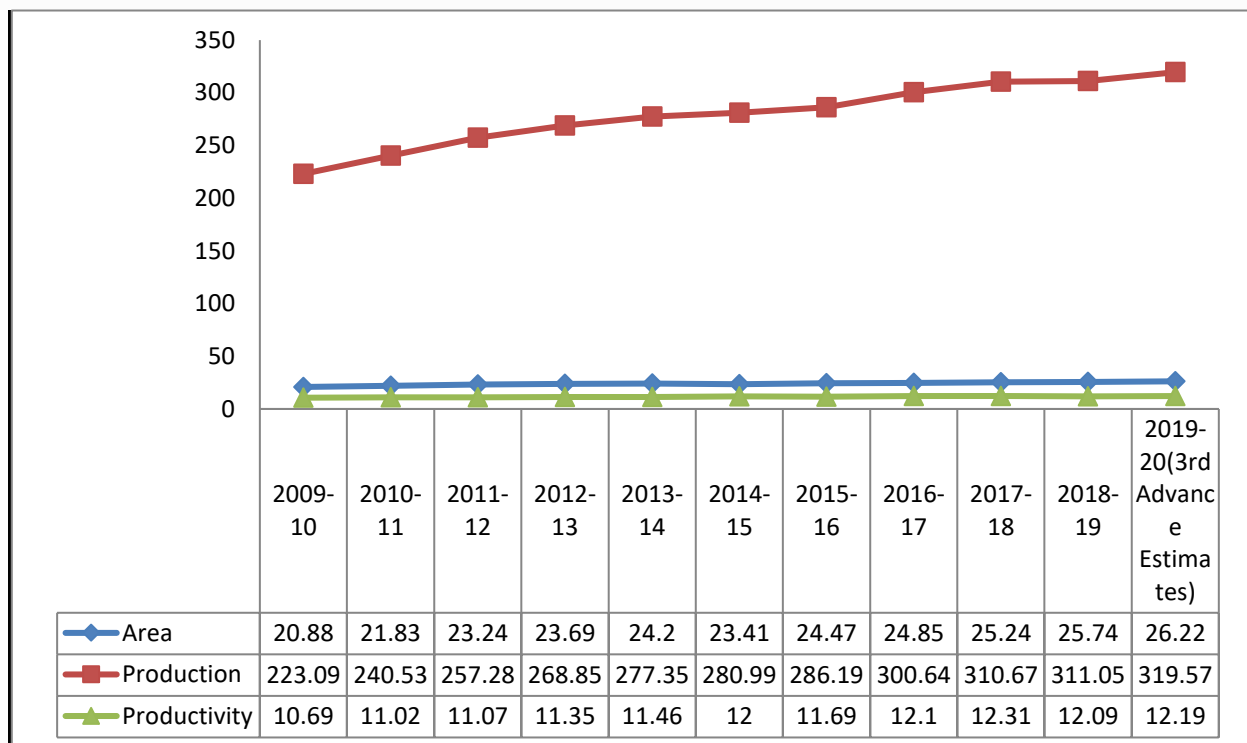
Sometimes floods play havoc with our crops. As irrigation facilities are quite inadequate, the agriculture depends on monsoon.

Crop	Area			Production			Productivity		
	2004-5	2018-19	2019-20*	2004-5	2018-19	2019-20*	2004-5	2018-19	2019-20*
Fruits	5049	6597	6702	50867	97967	100448	10.07	14.85	14.99
Vegetables	6744	10073	10316	101246	183170	189464	15.01	18.18	18.37
Flowers	118	303	307	659	2910	2994	5.58	9.6	9.76
Aromatic & Medicinal crops	131	627	685	159	795	761	1.21	1.27	1.11
Plantation crops	3147	4069	4071	9835	16592	16031	3.13	4.08	3.94
Spices	3150	4067	4138	4001	9500	9754	1.27	2.37	2.36
Others	106			172	120	115			
Total	18445	25737	26219	166939	311052	319567	9.05	12.09	12.19



Labour intensive cultivation: Due is increase in population the pressure on land holding increased. Land holdings get fragmented and subdivided and become uneconomical. Machinery and equipment cannot be used on such farms, Under employment: Due to inadequate irrigation facilities

and uncertain rainfall, the production of agriculture is less, farmers find work a few months in the year. Their capacity of work cannot be properly utilised. In agriculture there is under employment as well as disguised unemployment.



Agarwal, Kabir (9 March 2021, Small size of holdings: Due to large scale sub-division and fragmentation of holdings, land holding size is quite small. Average size of land holding was 2.3 hectares in India while in Australia it was 1993 hectares and in USA it was 158 hectares.

- Traditional methods of production: In India methods of production of agriculture along with equipment are traditional. It is due to poverty and illiteracy of people. Traditional technology is the

main cause of low production.

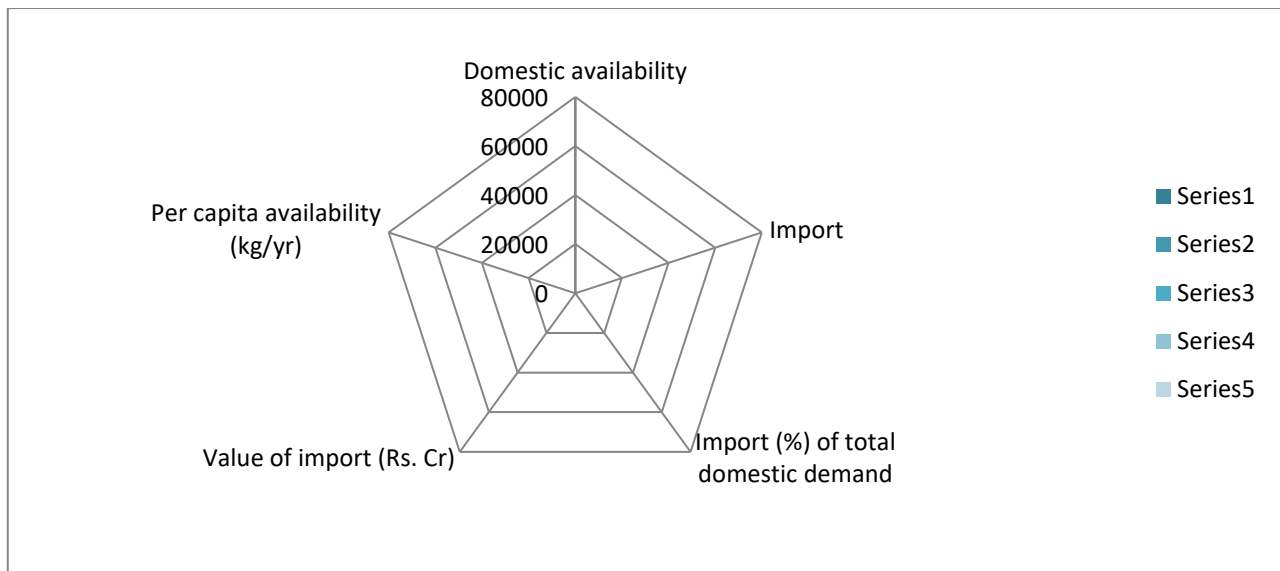
- **Anburaja, V. and Nandagopalan, V. (2012)** , Low Agricultural production: Agricultural production is low in India. India produces 27 Qtls. wheat per hectare. France produces 71.2 Qtls per hectare and Britain 80 Qtls per hectare. Average annual productivity of an agricultural labourer is 162 dollars in India, 973 dollars in Norway and 2408 dollars in USA.

- Dominance of food crops: 75% of the cultivated area is under food crops like Wheat, Rice and Bajra, while 25% of cultivated area is under commercial crops. This pattern is cause of backward agriculture.

Total domestic demand		Domestic availability		Import		Import (%) of total domestic demand		Value of import (Rs. Cr)		Per capita availability (kg/yr)	
Mean	24.758	Mean	10.022	Mean	14.736	Mean	59.542	Mean	68626.4	Mean	19.33
Standard Error	0.449515	Standard Error	0.358739	Standard Error	0.386776	Standard Error	1.247732	Standard Error	2493.182	Standard Error	0.193391
Median	24.97	Median	10.35	Median	14.85	Median	60.06	Median	68677	Median	19.3
Mode	#N/A	Mode	#N/A	Mode	#N/A	Mode	#N/A	Mode	#N/A	Mode	#N/A
Standard Deviation	1.005147	Standard Deviation	0.802166	Standard Deviation	0.864858	Standard Deviation	2.790013	Standard Deviation	5574.925	Standard Deviation	0.432435
Sample Variance	1.01032	Sample Variance	0.64347	Sample Variance	0.74798	Sample Variance	7.78417	Sample Variance	31079787	Sample Variance	0.187
Kurtosis	1.85869	Kurtosis	3.888912	Kurtosis	1.587053	Kurtosis	0.731226	Kurtosis	1.8842	Kurtosis	1.44053
Skewness	0.26843	Skewness	1.91144	Skewness	1.21404	Skewness	0.19197	Skewness	0.14886	Skewness	0.27221
Range	2.44	Range	2.02	Range	2.22	Range	7.61	Range	13437	Range	1.05
Minimum	23.48	Minimum	8.63	Minimum	13.35	Minimum	55.63	Minimum	61559	Minimum	18.75
Maximum	25.92	Maximum	10.65	Maximum	15.57	Maximum	63.24	Maximum	74996	Maximum	19.8
Sum	123.79	Sum	50.11	Sum	73.68	Sum	297.71	Sum	343132	Sum	96.65
Count	5	Count	5	Count	5	Count	5	Count	5	Count	5
Largest(1)	25.92	Largest(1)	10.65	Largest(1)	15.57	Largest(1)	63.24	Largest(1)	74996	Largest(1)	19.8
Smallest(1)	23.48	Smallest(1)	8.63	Smallest(1)	13.35	Smallest(1)	55.63	Smallest(1)	61559	Smallest(1)	18.75
Confidence Level(95.0%)	1.248055	Confidence Level(95.0%)	0.99602	Confidence Level(95.0%)	1.073864	Confidence Level(95.0%)	3.464258	Confidence Level(95.0%)	6922.184	Confidence Level(95.0%)	0.536939

Behera, K. K., Mandal, P. and Mahapatra, D. (2006), Agriculture, with its allied sectors, is unquestionably the largest livelihood provider in India, more so in the vast rural areas. It also contributes a significant figure to the Gross Domestic Product (GDP). Sustainable agriculture, in terms of food security, rural employment, and environmentally sustainable technologies such as soil conservation, sustainable natural resource management and biodiversity protection, are essential for holistic rural development. Indian agriculture and allied activities have witnessed a green revolution, a white revolution, a yellow revolution and a blue revolution.

This section provides the information on agriculture produces; machineries, research etc. Detailed information on the government policies, schemes, agriculture loans, market prices, animal husbandry, fisheries, horticulture, loans & credit, sericulture etc. is also available.



Agriculture based cooperatives

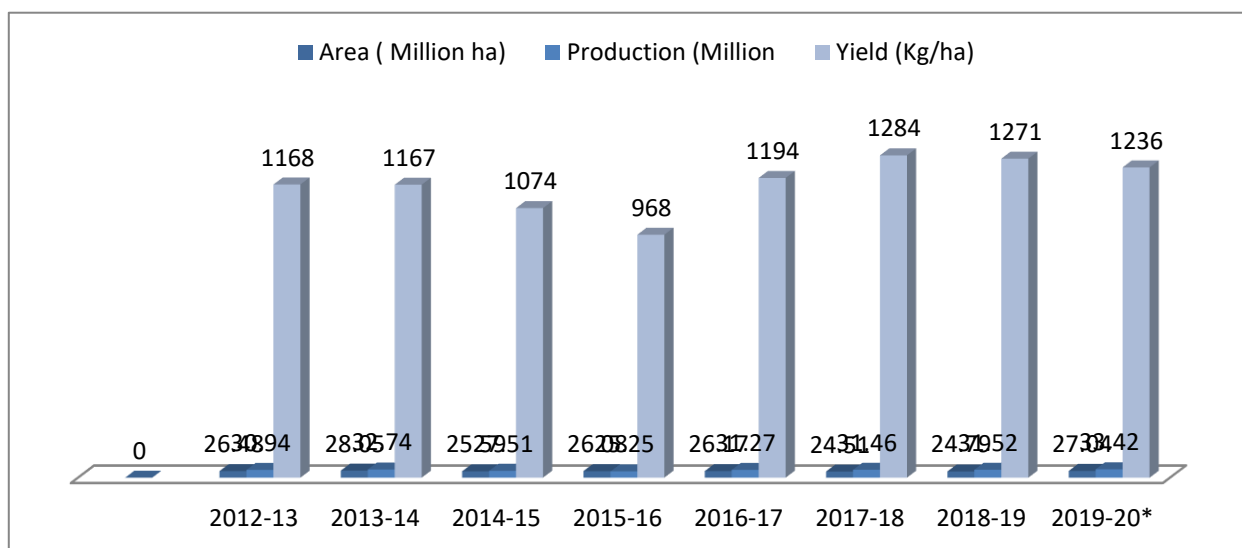
India has seen a huge growth in cooperative societies, mainly in the farming sector, since 1947 when the country gained independence from Britain. The country has networks of cooperatives at the local, regional, state and national levels that assist in agricultural marketing. The commodities that are mostly handled are food grains, jute, cotton, sugar, milk, fruit and nuts^[94] Support by the state government led to more than 25,000 cooperatives being set up by the 1990s in the state of Maharashtra.

Behera, K. K., Mandal, P. and Mahapatra, D. (2006) , Most of the sugar production in India takes place at mills owned by local cooperative societies.^[67] The members of the society include all farmers, small and large, supplying sugarcane to the mill.^[96] Over the last fifty years, the local sugar mills have played a crucial part in encouraging political participation and as a stepping stone for aspiring politicians.^[97] This is particularly true in the state of Maharashtra where a large number of politicians belonging to the Congress party or NCP had ties to sugar cooperatives from their local area and has created a symbiotic relationship between the sugar factories and local politics.^[98] However, the policy of "profits for the company but losses to be borne by the government", has made a number of these operations inefficient.^{[99][95]}

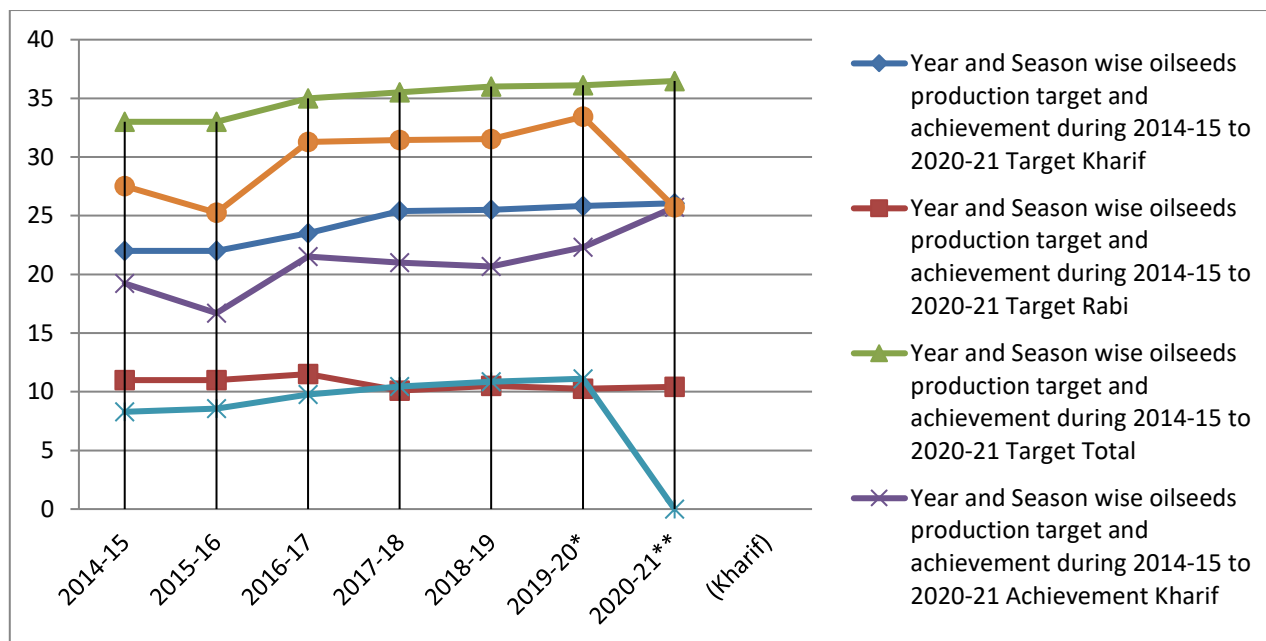
Poulopoulos, S., and V. Inglezakis, eds.(2016) , As with sugar, cooperatives play a significant part in the overall marketing of fruit and vegetables in India. Since the 1980s, the amount of produce handled by Cooperative societies has increased exponentially. Common fruit and vegetables marketed by the societies include bananas, mangoes, grapes, onions and many others.

Anburaja, V. and Nandagopalan, V. (2012) , Dairy farming based on the Amul Pattern, with a single marketing cooperative, is India's largest self-sustaining industry and its largest rural employment provider. Successful implementation of the Amul model has made India the world's largest milk producer.^[101] Here small, marginal farmers with a couple or so heads of milch cattle queue up twice daily to pour milk from their small containers into the village union collection points. The milk after processing at the district unions is then marketed by the state cooperative federation nationally under the Amul brand name, India's largest food brand. With the Anand pattern three-fourth of the price paid by the mainly urban consumers goes into the hands of millions of small dairy farmers, who are the owners of the brand and the cooperative.

Year	Area (Million ha)	Production (Million	Yield (Kg/ha)
		tonnes)	
2012-13	26.48	30.94	1168
2013-14	28.05	32.74	1167
2014-15	25.59	27.51	1074
2015-16	26.08	25.25	968
2016-17	26.17	31.27	1194
2017-18	24.51	31.46	1284
2018-19	24.79	31.52	1271
2019-20	27.04	33.42	1236



Year and Season wise oilseeds production target and achievement during 2014-15 to 2020-21						
Year	Target			Achievement		
	Kharif	Rabi	Total	Kharif	Rabi	Total
2014-15	22	11	33	19.22	8.29	27.51
2015-16	22	11	33	16.7	8.55	25.25
2016-17	23.5	11.5	35	21.53	9.75	31.28
2017-18	25.4	10.1	35.5	21.01	10.45	31.46
2018-19	25.5	10.5	36	20.67	10.84	31.52
2019-20*	25.84	10.26	36.1	22.32	11.11	33.43
2020-21**	26.06	10.42	36.48	25.73	-	25.73
(Kharif)						



THE FOOD PROCUREMENT AND DISTRIBUTION SYSTEM

In addition to policies on land distribution, the Government has significant influence on the agricultural sector through other policy instruments, including subsidies for inputs, minimum price support arrangements and government procurement of food.

Anburaja, V. and Nandagopalan, V. (2012) , One-third of input subsidies are paid in the form of fertiliser subsidies, which are equivalent to 1 per cent of GDP. Under this subsidy scheme, the Government quotes a maximum retail price for various types of fertilisers and reimburses the seller the difference between the retail price and the ‘market’ price. The market price for domestically produced fertilisers takes into **Agarwal, Kabir (9 March 2021)**, account transportation, storage, labour and energy costs. The subsidy for imported fertiliser is the difference between the import price and the maximum retail price. Urea fertilisers are a major input into agricultural production and its price has been fixed since 2003 despite large fluctuations in the cost of inputs. While India is able to produce enough urea fertiliser to meet domestic needs, it relies on imports to satisfy its demand for compound fertilisers, so that the increase in global fertiliser prices during 2007 and 2008 saw a large outlay in the subsidies paid for compound fertilisers (Graph 7). There are also substantial subsidies for electricity. Many farms use unmetered power and pay a subsidised lump-sum based on the power ratings of pump-sets used for irrigation purposes.

Sr.	Components	Achievement (as on 31.12.2020)		Projection for January – March, 2021
		2019-20	2020-21	2020-21
No.				
1	Propagation and Nursery (in nos.)	54	0	20
	Cultivation and Plantation (in ha)	7141	355	3216
2	Promotion of bamboo treatment and preservation (in nos.)	12	3	6
3	Product Development and Processing (in nos.)	47	10	28
4	Promotion and Development of Infrastructure for Bamboo Market (in nos.)	20	3	9

5	Development of tools, equipment & machinery (in nos.)	509	1	280	
6	Skill Development and awareness campaign	Capacity Building Training (in no. of persons)	3275	1274	1375
		Workshop/ seminar/ trade fairs/exhibition (in nos.)	64	7	8
7	Research & Development (in nos.)	62	3	9	

ANOVA: SINGLE FACTOR

SUMMARY

Groups	Count	Sum	Average	Variance
54	8	11130	1391.25	6643524
0	8	1656	207	200926.6
20	8	4931	616.375	1324769

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	5787913	2	2893956	1.062754	0.363366	3.4668
Within Groups	57184535	21	2723073			
Total	62972448	23				

Behera, K. K., Mandal, P. and Mahapatra, D. (2006), New crops and crop rotation systems were tried during the Agricultural Revolution in India. These new farming methods allowed the earth to recover nutrients, resulting in stronger crops and increased agricultural production. Productivity was boosted much more by improvements in irrigation and drainage.



In India, many different types of farming are practised, including maintenance, commercial farming, extensive and intensive farming, plantation farming, and mixed farming. Many factors affect running an agriculture farm in India, and all of these practices are dependent on animals, the monsoon, and crops.

Crops in India are classified into four types: food crops, plantation crops, cash crops, and cereals. **Anburaja, V. and Nandagopalan, V. (2012)**, Soil exhaustion, high farm input costs, depletion of fresh groundwater, globalisation and liberalisation, climate change, farmer suicide, and food security are major challenges for Indian agriculture. These causes

suppressed agricultural production, which led to an Agricultural Revolution in India.

AGRICULTURAL REVOLUTION IN INDIA

- **Bhagat, R. B. (2013)**, An agricultural revolution occurs as a result of discoveries, inventions, or the implementation of new technologies and creating consumer-oriented policies. It is changing the production methods, increasing production rates, and taking several agricultural revolutions in India.

- Higher production is also known as the Technology-Driven Second Green Revolution, a term coined by Prime Minister Narendra Modi and Finance Minister Arun Jetley.
- A Rs. 500 crore price stabilisation fund has been established to assist farmers in dealing with volatility. A TV channel has also been established to provide farmers with information on water conservation, organic farming, and other new techniques.

EVER - GREEN REVOLUTION

Deshpande, Tanvi (2021) Ever Green Revolution: primarily focuses on overall agricultural production, began in the 11th five-year plan.

- M.S Swaminathan is widely regarded as the “Father of the Ever Green Revolution” in India, who emphasised the importance of increasing productivity in order to exist and last long while minimising environmental and social harm. **Choudhary, Nitu (9 December 2020).**

GREEN REVOLUTION:



During this time, advanced technologies were introduced and implemented to the agriculture sector, and agricultural productivity increased globally.

Dr. Norman Borlaug is known as the “Father of the Green Revolution.” This Revolution’s ultimate motive was to save a billion people from starvation. **Sinha, R.K. (2010).**

FARMER APPLICATION (X)	AREA INSURED (LAKH HA:) (Y)
357.7	379.7
175.3	187.6
533	567.3
345.3	330.7
231.4	177.7
576.8	508.3
419.8	317.4
190.4	205.6
610.2	523
398.4	326.4

SUMMARY OUTPUT

<i>Regression Statistics</i>	
Multiple R	0.993061
R Square	0.986169
Adjusted R Square	0.875058
Standard Error	46.77251
Observations	10

ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	140389	1403895	641.731	6.32E-09
Residual	9	19689.0	2187.66		

Total	10	142358						
		4						
	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
FARMER APPLICATION (X)	0.910948	0.03596	25.3324	1.12E-09	0.829601	0.992294	0.829601	0.992294

RESIDUAL OUTPUT

PROBABILITY OUTPUT

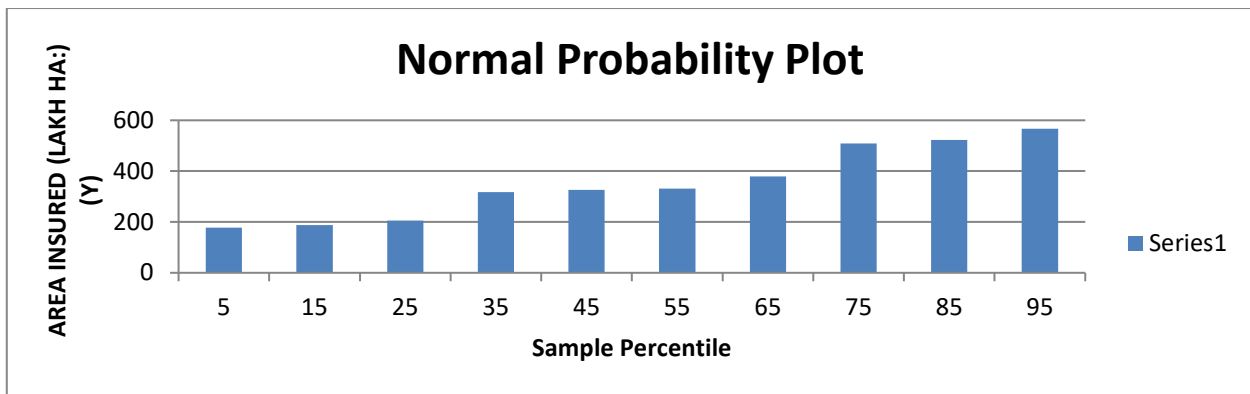
<i>Observation</i>	<i>Predicted AREA INSURED (LAKH HA:.) (Y)</i>	<i>Residuals</i>	<i>Standard Residuals</i>	<i>Percentile</i>	<i>AREA INSURED (LAKH HA:.) (Y)</i>
1	325.8459	53.85407	1.213687	5	177.7
2	159.6891	27.9109	0.629016	15	187.6
3	485.535	81.76496	1.842703	25	205.6
4	314.5502	16.14981	0.363962	35	317.4
5	210.7933	-33.0933	-0.74581	45	326.4
6	525.4345	-17.1345	-0.38615	55	330.7
7	382.4158	65.0158	1.46523	65	379.7
8	173.4444	32.15559	0.724677	75	508.3
9	555.8602	-32.8602	-0.74056	85	523
10	362.9215	36.5215	0.82307	95	567.3

WHITE REVOLUTION:

- **Sinha, R.K. (2010)** , Verghese Kurien, also known as the Milk Man of India, is the founder of the White Revolution, which focuses primarily on milk and dairy products.



The White Revolution is a legendary success story of the country’s dairy cooperative movement. The Indian government launched the Operation Flood Program with international assistance.

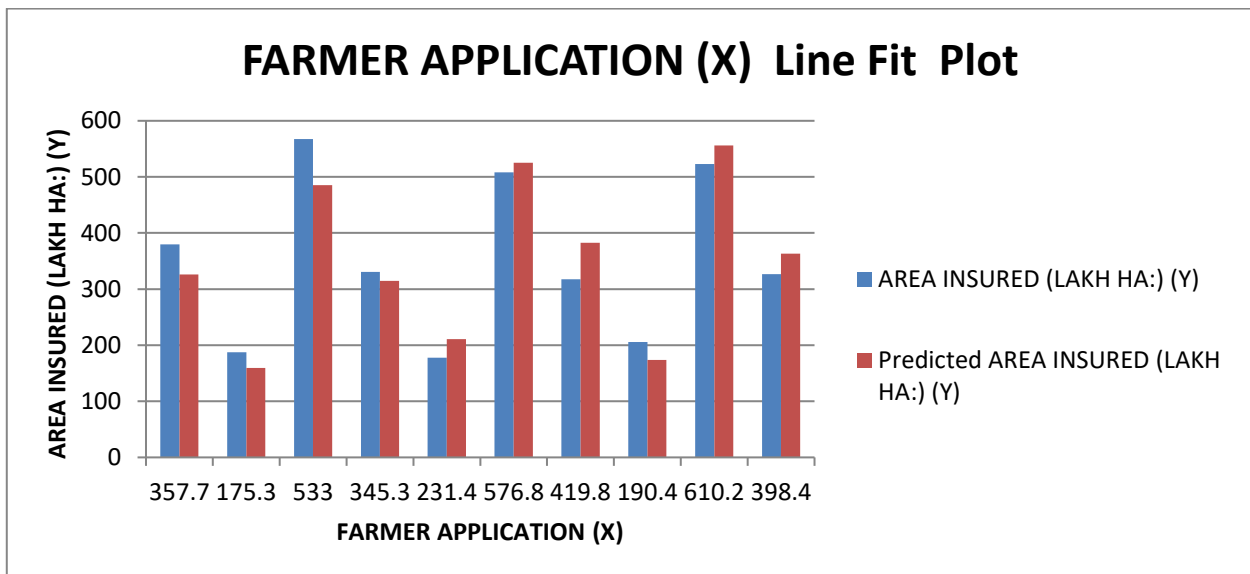


YELLOW REVOLUTION:



Agarwal, Kabir (9 March 2021, Oilseed Production (Especially Mustard and Sunflower). The name of Yellow Revolution’s Father is Sam Pitroda.

The main contributors of this revolution are oil seed production technology, price and market intervention support policy, the area under oilseed expansion, and institutional support.



Clark, C. (1976) , The term “agricultural revolution” refers to major agricultural changes brought about by innovations, discoveries, or new technology—agricultural revolutions in India altered industrial methods and enhanced output rates. Several agricultural revolutions in India signalled the start of an entirely new age in agriculture. Indian agriculture grew enormously as a result of the agricultural revolutions in India, which opened up new prospects.



- The term "green revolution" describes the dramatic rise in food grain output, particularly for wheat and rice, that began in the middle of the 20th century and was largely attributed to the introduction of new, high-yielding variety (HYV) seeds into developing nations.
- Large-scale alterations were made to conventional farming methods starting in the 1960s.

Dr. M. S. Swaminathan, the advisor to India's minister of agriculture, extended an invitation to Norman Borlaug to visit. *Deshpande, Tanvi (2021)*

- In India, M.S Swaminathan is regarded as the father of the Indian Green Revolution.
- The Green Revolution in India began in 1968, led by Prime Minister Indira Gandhi, and resulted in an increase in food grain output, particularly in Punjab, Haryana, and Uttar Pradesh.
- **Sinha, R.K. (2010)** , The development of new synthetic insecticides, herbicides, and chemical fertilizers occurred during this time. It solved India's issue of food insecurity.

LAND REFORMS :

- **Choudhary, Nitu (9 December 2020)** , Land Reform was introduced in order to improve the nation's agricultural position, and land reforms needed to be implemented right away.
- Tenancy-at-will, sharecropping, and absentee landlordism all failed to pique farmers' enthusiasm for investing in modern farming technologies and inputs.
- In 1947, the Zamindari System, which placed 80% of the country's land in the hands of absentee landlords, applied to half of India. **Choudhary, Nitu (9 December 2020)**.
- The Zamindar used to take advantage of the farmers who worked the land.
- The phrase "land to the tiller" was used shortly after independence, and actions were launched to abolish the Zamindari. Tenants consequently acquired land ownership.

IMPACT OF GREEN REVOLUTION :

POSITIVE IMPACTS :

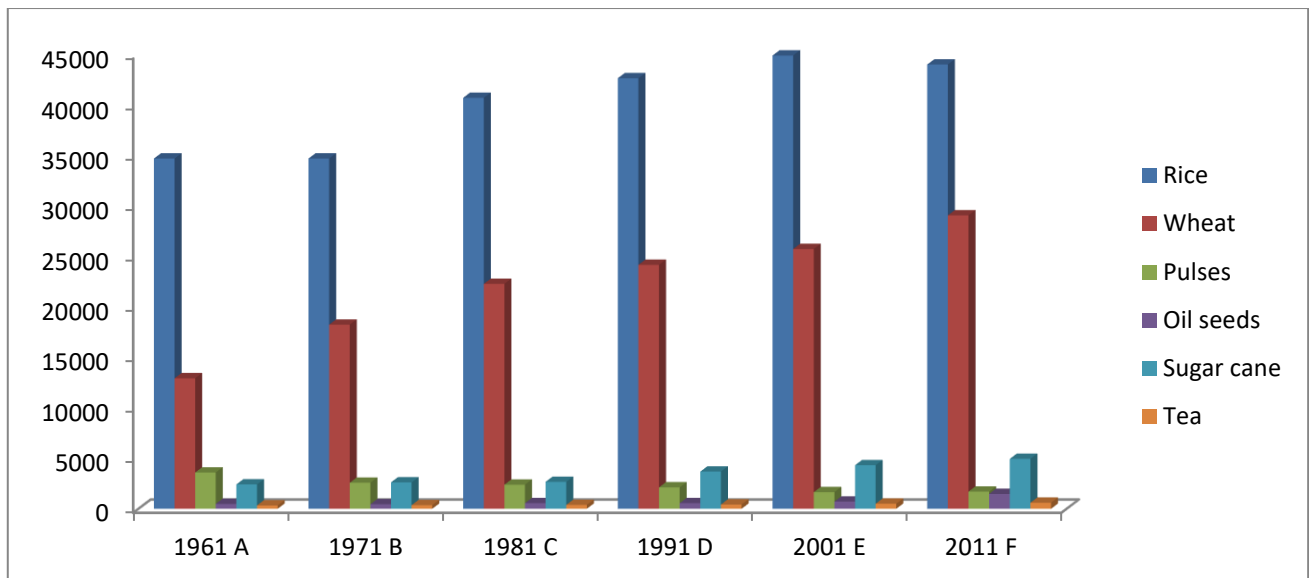
- **Bhagat, R. B. (2013)** , Tens of millions more tonnes of grain are being harvested annually as a result of the high-yield variety seeds.
- In 1978–1979, the Green Revolution led to a record grain output of 131 million tonnes.
- India was now recognized as one of the top agricultural producers in the world.
- Between 1947 and 1979, the yield per unit of agricultural land increased by more than 30%.
- By building connected facilities like **Bhagat, R. B. (2013)** , factories and hydroelectric power plants, the Green Revolution also generated a large number of jobs for industrial employees as well as agricultural laborers.

NEGATIVE IMPACTS :

- **Behera, K. K., Mandal, P. and Mahapatra, D. (2006)**, India has not succeeded in implementing the idea of high-yield variety seeds across all crops or geographical areas.
- In terms of crops, it mostly focused on food grains and excluded other types of agricultural products.
- Only the states of Punjab and Haryana demonstrated the finest Green Revolution outcomes regionally.

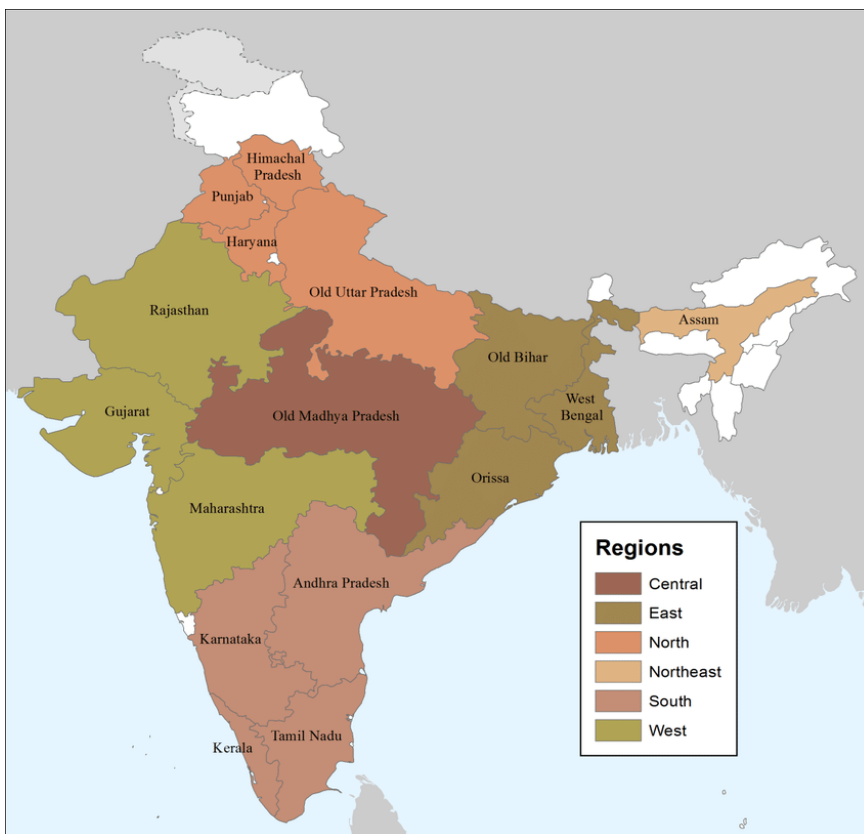
- **K. V. Subrahmanyam; T. M. Gajanana (2000)** , The Ganges River's eastern lowlands in West Bengal have produced some respectable outcomes. However, outcomes in other parts of India were less noteworthy.
- Environmentalists and others have studied the long-term repercussions of the green revolution and claim that it exacerbated sociological, economic, and environmental issues like farmer suicides, rural indebtedness, and droughts.
- According to reports, the usage of pesticides has deteriorated the soil, which has caused many agricultural systems to fail across the nation, harming the farmers' livelihoods as well as the food and water supplies.
- **Clark, C. (1976)** , The disparity in farmer income increased inter-personal as well as inter-regional disparities/inequalities in India.
- A rise in the incidence of malaria as a result of waterlogging, a shift in balanced cropping patterns in favour of wheat and rice, pushing pulses, oilseeds, maize, and barley to the margins, and other negative effects.
- When the media, scholars, experts, and environmentalists raised concerns about it, neither governments nor the general public were convinced.
- **Clark, C. (1976)** The term "Evergreen Revolution" was coined by Dr. M. S. Swaminathan to describe a strategy for improving output and productivity without compromising short- and long-term food production goals.
- The objective is to produce more using fewer resources—less water, less pesticide, and less land—and to achieve sustainable agriculture, there must be an evergreen revolution.
- The productivity of farms can be increased by introducing modern information and communication technology (ICT) to Indian farmers.
- Through networking on weather alerts, planting season, and produce prices, ICT projects can address important issues in the agricultural value chain. **Sinha, R.K. (2010)**.
- **K. V. Subrahmanyam; T. M. Gajanana (2000)** , One of the pillars of the Digital India initiative, e-Kranti, focuses on technology for farmers and offers real-time pricing updates, online input ordering, and mobile banking for payment.

CROP	1961 A	1971 B	1981 C	1991 D	2001 E	2011 F
Rice	34694	34694	40708.4	42648.7	44900	44010
Wheat	12927	18240.5	22278.8	24167.1	25730.6	29068.6
Pulses	3592	2582.8	2388	2123.1	1650	1700
Oil seeds	486	453.3	557.5	557.5	716.7	1471
Sugar cane	2413	2615	2666.6	3686	4315.7	4944.39
Tea	331.23	358.675	384.242	421	504	600



BRINGING GREEN REVOLUTION TO EASTERN INDIA :

- **Poulopoulos, S., and V. Inglezakis, eds.(2016)** , The "Bringing Green Revolution to Eastern India" is a program that was introduced in 2010–2011 to address the issues restricting the productivity of "rice-based agricultural systems" in eastern India.



- It focuses on seven States namely: Assam, Bihar, Chhattisgarh, Jharkhand, Odisha, Eastern Uttar Pradesh (Purvanchal), and West Bengal.

- **Choudhary, Nitu (9 December 2020)**, As part of the program, assistance is given to the farmers with organizing cluster demonstrations of rice and wheat, seed production and distribution, nutrient management and soil ameliorants, integrated pest management, cropping system-based training, asset-building with things like farm machinery and tools, irrigation devices, site-specific activities, post-harvest & marketing support, etc.

- The application of land use , In accordance with the program, the Government of India distributes funds to the State, which then distributes them to the

district. **Bhagat, R. B. (2013).**

- These systems already cover other crops like wheat, coarse-cum-Nutri cereals, pulses, and oilseeds

PERCENTILE RANK

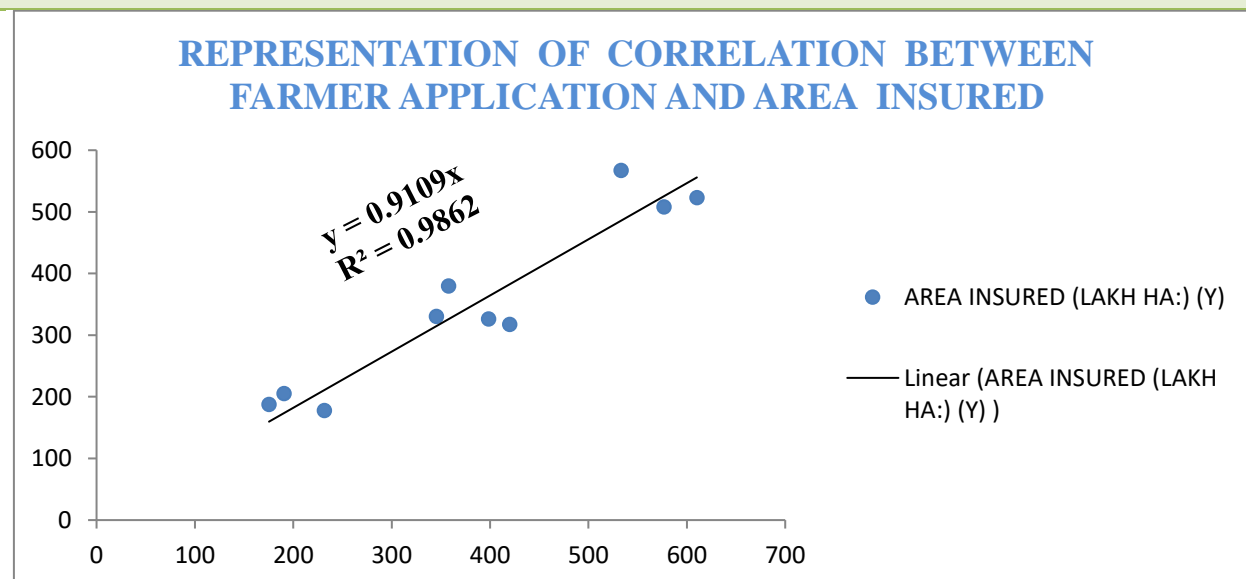
Point	UTTAR PRADESH	Rank	Percent	Point	KERALA	Rank	Percent	Point	WEST BENGAL	Rank	Percent
1	34694	1	100.00%	1	34694	1	100.00%	1	40708.4	1	100.00%
2	12927	2	80.00%	2	18240.5	2	80.00%	2	22278.8	2	80.00%
3	3592	3	60.00%	5	2615	3	60.00%	5	2666.6	3	60.00%
5	2413	4	40.00%	3	2582.8	4	40.00%	3	2388	4	40.00%
4	486	5	20.00%	4	453.3	5	20.00%	4	557.5	5	20.00%
6	331.229	6	0.00%	6	358.675	6	0.00%	6	384.242	6	0.00%

COVARIANCE OUT PUT

	UTTAR PRADESH	KERALA	WEST BENGAL
UTTAR PRADESH	149306840.4		
KERALA	153423720.4	1.62E+08	
WEST BENGAL	181632983.4	1.92E+08	2.29E+08

CORRELATION OUT PUT

	UTTAR PRADESH	KERALA	WEST BENGAL
UTTAR PRADESH	1		
KERALA	0.986921409	1	
WEST BENGAL	0.982402459	0.999597	1



CONCLUSION:

Overall, land use change and the Green Revolution offered India, a level of national food security that had never before been possible. It symbolized the effective transfer of the same agricultural scientific **Clark, C. (1976)** revolution that the industrialized nations had previously grabbed for themselves. The environment, underprivileged farmers, and their knowledge of **Behera, K. K., Mandal, P. and Mahapatra, D. (2006)**, such chemicals were given less attention than other considerations such as guaranteeing food security. Therefore, the production, in order for the poor to benefit more directly from new technologies and for those technologies to be more environmentally friendly, governments must more precisely target the poor. Additionally, land use model is more relevant for taking into account the lessons learned from the past, it

must be made sure that such initiatives cover all of the beneficiaries across all regions rather than focusing only on a small area in india .

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