

## Changing Pattern of Agricultural Production in Assam: A Geographical Analysis

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### Abstract

Agriculture sector plays a remarkable role in the economy of Assam. More than 60% resident of the state are directly or indirectly relies upon this division for their livelihood. The diverse agro climatic regions of the state provide congenial environment for the growth and advancement of agricultural crops in the state. Though there has been significant progress in the agricultural front the development in this sector cannot cope with the demand of the growing population in respect of production of various crops. As the scope for horizontal expansion of this sector is limited, the only way to feed the growing millions is by increasing the production through increasing the intensity of cropping an using various scientific methods like cultivation of HYV seeds, extending irrigation facilities, using fertilisers and manures etc. The present paper based on data collected from different Government offices aims to analyse the changing pattern of agricultural production in the state. The finding reveals that along with the significant increase in the production, the consumption of chemical fertilisers is also increasing. The agricultural operated area shows a decreasing trend in the state by 3.69% in 2010-11 over 200 -2001 due to soil erosion, increasing urbanisation and industrialisation. The consumption of chemical pesticide increased to 50.39% in 2016-17 over 2008-09.

**Keywords: Agricultural production, Horizontal expansion, HYV seeds, Chemical fertiliser**

### I. Introduction

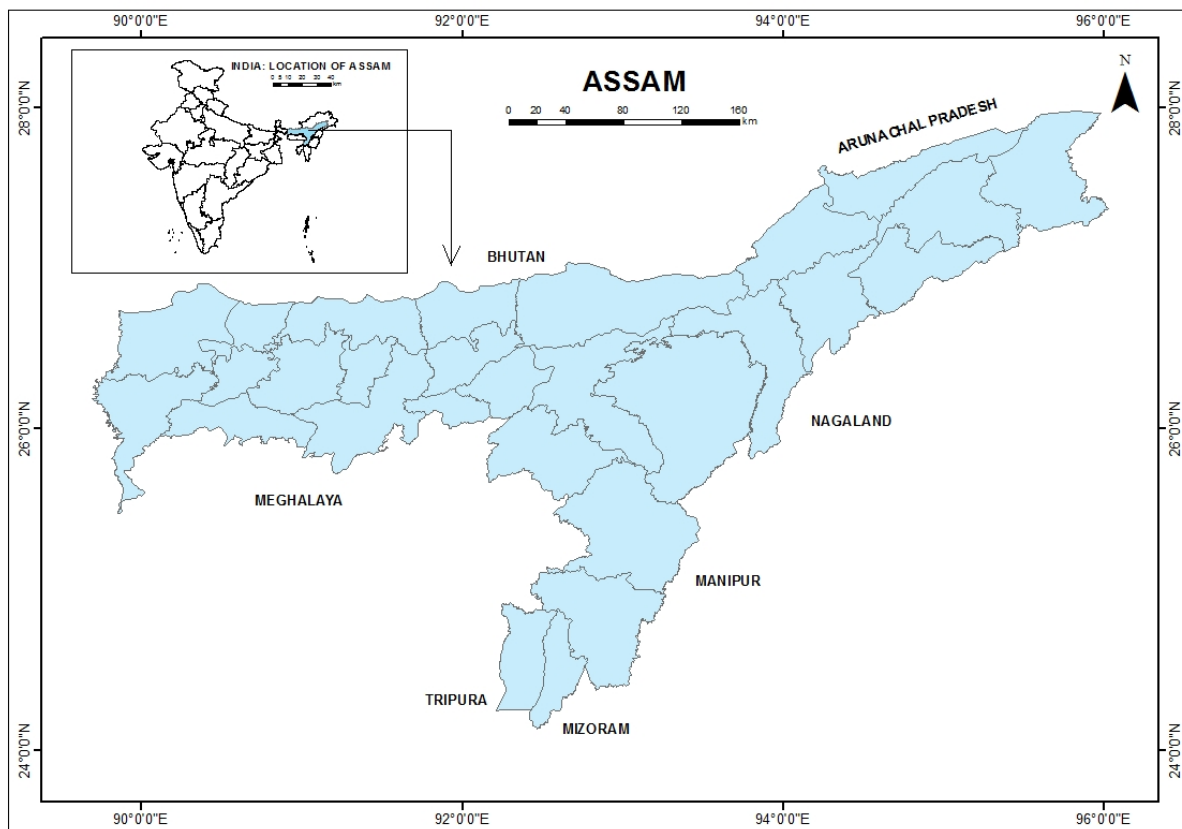
Agriculture is the backbone of the Indian economy that made an indispensable contribution towards the national income, employment generation as well as the industrial development of the nation. In India, about 58% population depends on agriculture as their major means of livelihood and this sector along with fisheries and forestry contributes more than 17% of the national GDP (Wagh & Dongre, 2016). Like other India states, the economy of Assam also mainly depends on agricultural activities. The diverse ecological setting of the river valleys, hills and ridges and other micro physiographic units combined with varying socio-economic factors have produced significant spatial variation in the pattern of agricultural land utilisation in the state (Bhagabati, 1990). More than 70% population of the state are associated with the agricultural sector and contributed about 20% to the State Domestic Product during 2014-15 (Saud, 2018). Although the share of agriculture to the state income is still high as compared with most of the Indian state, it has been gradually declining due to the growth of other sectors of the economy (Sarmah, 2012). The total cultivable area of the state is 30.16 lakh hectare representing 38.45% of the total geographical area. Net cropped area is 28.11 hectares which is about 93.20% of the total cultivable area. The cropping intensity of the state is 146% (Directorate of Agriculture, Government of Assam, 2016-17).

The traditional methods of farming are not prolific in recent years according to the ever-increasing requirement of food, because it has many weaknesses like diseases and pest management, making them economically less beneficial (Alam et al., 2014). So various new technologies are adopting in agriculture to get more yield of crops that can be full fill the needs of the human population. But the agricultural sector facing significant problems, especially in developing countries where farmers can't afford modern agricultural

technologies (Kellengere Shankarnarayan & Ramakrishna, 2020). The farmer of Assam also faces this problem due to their poor economic condition and lack of modern technologies. The state is still far behind in the use of recent agricultural technology to increase its agricultural productivity compared to the other Indian states. However, the agriculture department of the state in recent years has given emphasis on increasing production of food grains through increasing productivity.

## II. Study Area

The present study encompasses the state of Assam, having latitudinal extension from 24.3° N to 28° N and longitudinal extension from 89.5° E to 96.1° E (**Fig 1**). Surrounded on three sides by hills and mountains, it has a total geographical area of 78438 sq. km. representing 2.39% of the Indian landmass. It is one of the most populous states in North-East India with a total population of 31,169,272 persons (2011). The state is surrounded by two foreign countries namely Bhutan and Bangladesh and seven Indian states like Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Meghalaya and West Bengal.



**Fig. 1: Location of the Study Area**

## III. Objectives

1. To analyse the changing pattern of agricultural production with special reference to major food grains i.e. Rice, Wheat and Pulses.
2. To identify the factors of agricultural development especially the inputs used in farming practices.

#### IV. Database and Methodology

The present study is mainly based on secondary data collected from the different sources. The three major food grains i.e. rice, wheat and pulses are used to analyse the changing pattern of agricultural scenario of the State. Relevant data on annual production of food grains, consumption of nutrients, fertilisers and pesticides have been collected from Directorate of Agriculture, Government of Assam. Status of farm mechanisation and irrigation is analysed based on data published by Economic Survey of Assam for different years. The yield rate of principal agricultural crops have been analysed based on the data collected from Directorate of Economics and Statistics, Assam. The agricultural census report has also been used in order to calculate the average size of landholdings in the state. The Data collected from different sources have been systematically arranged. In order to compile and analyze them qualitative and cartographic techniques have been used. Some meaningful statistical and cartographic techniques were incorporated in the paper using Microsoft Excel, Google Earth Pro, ArcGIS 10.2.1 for processing and representing the data so obtained in the form of tables and charts.

#### V. Results and Discussion

##### Area under Food Grains

The cropland of Assam is generally dominated by the cultivation of food grains, viz. rice, wheat, maize, pulses, gram and small millets. Among these, rice as the staple food crop continues to dominate the state's agriculture (Bhagabati et al, 2001). The area under rice cultivation has witnessed a substantial increase after the introduction of high yielding varieties of rice in the last part of the 1960s. Wheat is cultivated as rabi crops in the districts of lower Assam whereas, pulses are grown in almost every district of Assam. The following table shows the area covered by Rice, Wheat and Pulses in different time period.

**Table 1: Total Area under selected food grains in Assam (in lakh hect.)**

Year	Rice	Wheat	Pulses	Total Food grains
2004-05	23.83	0.64	1.08	25.55
2005-06	24.20	0.50	1.00	25.70
2006-07	21.89	0.60	1.07	23.56
2007-08	23.24	0.56	1.13	24.93
2008-09	24.84	0.50	1.14	26.48
2009-10	25.29	0.60	1.19	27.08
2010-11	25.71	0.45	1.26	27.42
2011-12	25.46	0.40	1.32	27.18
2012-13	24.88	0.34	1.42	26.64
2013-14	25.03	0.31	1.50	26.84
2014-15	24.95	0.24	1.48	26.67
2015-16	24.85	0.21	1.42	26.48
2016-17	24.67	0.17	1.46	26.3

Source: Compiled and Estimated from data collected from Directorate of Agriculture Khanapara, Assam and Economic Survey of Assam

Table 1 reveals that, rice is the dominant food crop of the state covering 93.80% of the total area under food grains while, wheat and pulses occupy 0.65% and 5.55% respectively. Though, the total area under rice cultivation has increased from 23.83 lakh hect. in 2004-05 to 24.67 lakh hect. in 2016-17, it shows a declining trend from 2013-14 onwards. The total area under rice in 2013-14 was 25.03 lakh hect which was declined to 24.67 lakh hect in 2016-2017. Likewise, the total area under wheat cultivation is also decreasing in the state from 2004-05 onwards and reached to 0.17 lakh hect in 2016-17 as against 0.64 lakh hect in 2004-05. It is interesting to note that the area under pulses is depicting a positive change.

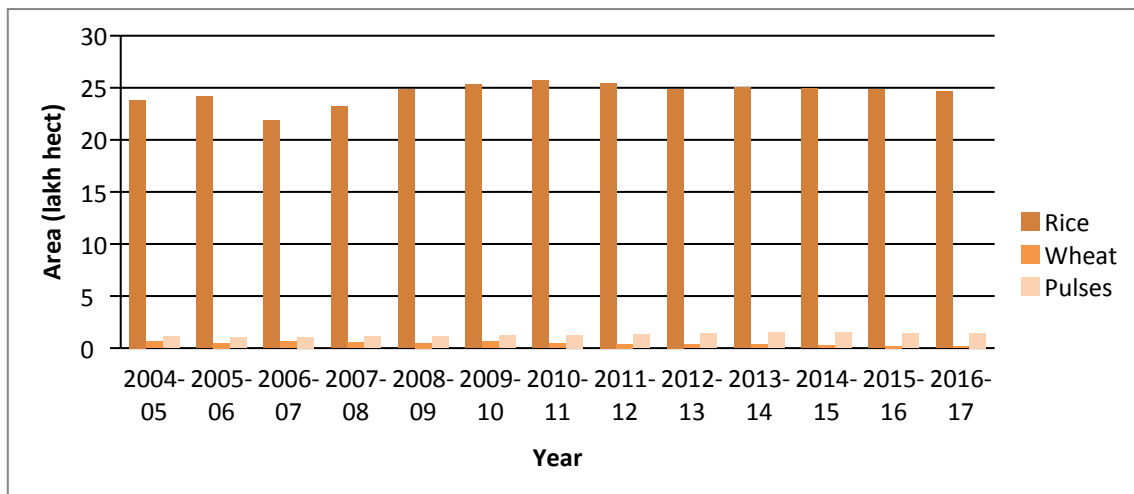


Fig. 2: Area under Major Food Grains.

### Production of Food Grains

Assam is categorised as highest ranked state for production of food grains in India. However, the Agricultural production in the state is plagued by decline of agricultural land, scattered and fragmented landholdings, slow spread of modern inputs and implements, pest attack, recurring floods etc (Goyari, 2005). The following table shows the production of major food grains in the state from 2001-02 to 2016-17

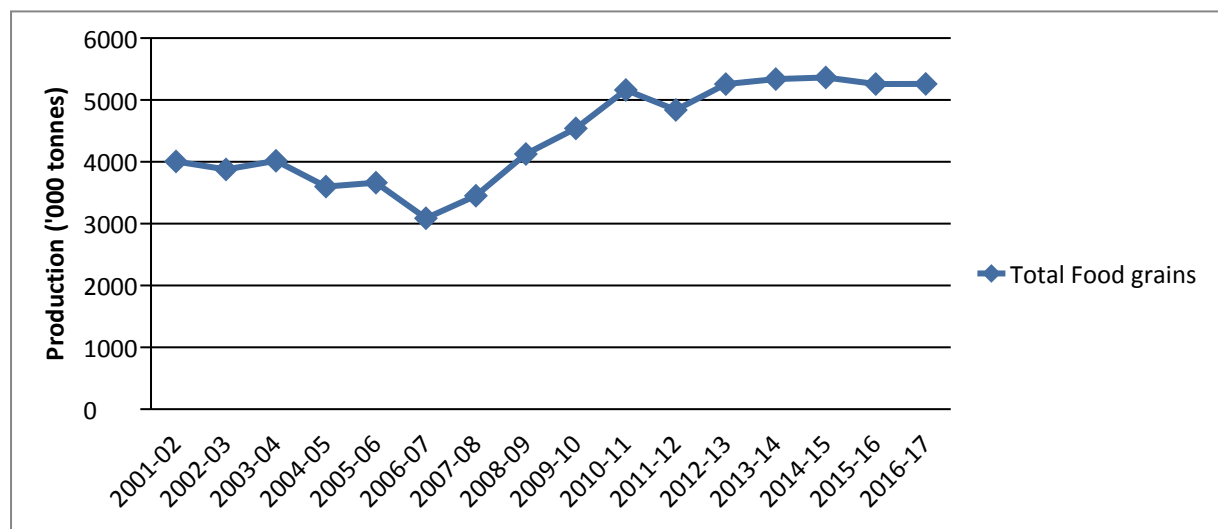
Table 2: Production of Major Food Grains (in '000 tonnes)

Year	Rice	Wheat	Pulses	Total Food grains
2001-02	3854	85	66	4005
2002-03	3738	78	60	3876
2003-04	3880	73	63	4016
2004-05	3470	68	61	3599
2005-06	3552	54	56	3662
2006-07	2961	67	59	3087
2007-08	3319	71	61	3451
2008-09	4009	55	62	4126
2009-10	4409	65	66	4540
2010-11	5033	56	72	5161
2011-12	4716	49	73	4838

2012-13	5128	44	84	5256
2013-14	5193	40	104	5337
2014-15	5223	29	111	5363
2015-16	5125	24	108	5257
2016-17	5127	23	109	5259

Source: Compiled and Estimated from data collected from Directorate of Agriculture Khanapara, Assam and Economic Survey of Assam

From table 2, it is evident that the total production of food grains has increased from 4005 thousand tonnes in 2001-02 to 5259 thousand tonnes in 2016-17. The highest production was seen in 2014-15 with a total production of 5363 thousand tonnes. Rice, being the principal food crop occupies 97.49% of the total food grains in 2016-17, while wheat and pulses occupies 0.44% and 0.72% respectively. The production of rice shows overall positive growth from 2001-02 to 2016-17 but from 2014-15 onwards it is facing a negative growth. The production of wheat has declined from 85 thousand tonnes in 2001-02 to 23 thousand tonnes in 2016-17. The production of total Pulses has increased from 66 thousand tonnes in 2001-02 to 109 thousand tonnes in 2016-17. This increasing trend of pulses continued since 2005-06. The variation in the total amount of production between these years is caused by various factors like uncertainty of rainfall, insufficient irrigation, dearth of capital etc.



**Fig. 3: Production of Major Food Grains**

### Productivity of Food Grains

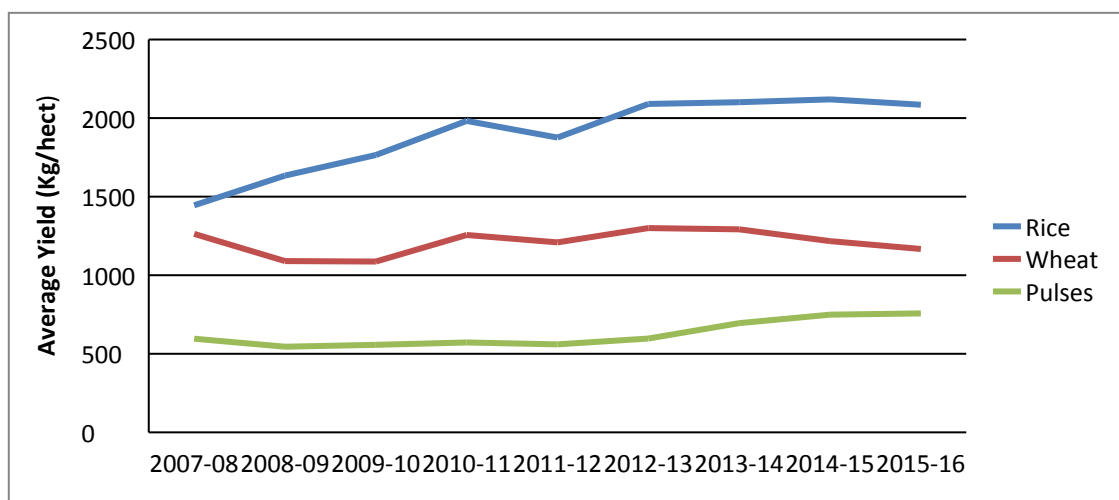
The crop productivity of any area means the crop-yield per unit of area and is a function of various physical, socio-economic and techno-organisational factors. In spite of having ideal conditions for attaining high agricultural productivity, the state is still lagging behind in this respect due to many impediments. The agricultural productivity in the state has shown a great degree of variability over the years. The following table shows the average yield rate of major food grains in Assam from 2007-08 to 2015-16.

**Table 3: Average Yield of Major Food Grains (Kg/hect)**

Year	Rice	Wheat	Pulses
2007-08	1445	1263	596
2008-09	1634	1090	545
2009-10	1765	1087	557
2010-11	1982	1256	572
2011-12	1876	1209	560
2012-13	2090	1300	597
2013-14	2101	1292	695
2014-15	2119	1217	749
2015-16	2085	1167	757

Source: Compiled and Estimated from data collected from Directorate of Agriculture Khanapara, Assam and Economic Survey of Assam

From table 3, it is found that the yield rate of major food grains is not consistent in the state. The yield rate of rice has increased from 1445 Kg/hect in 2007-08 to 2085 Kg/hect in 2015-16. The yield of rice was highest in 2014-15 (2119 kg/hect). However, in case of wheat the highest yield was recorded in 2012-13 (1300kg/hect). Pulses show an increasing trend over the years. The total yield of Pulses has increased from 596 Kg/hect in 2007-08 to 757 kg/hect in 2015 to 16.



**Fig. 4: Trend of Average Yield of Major Food Grains**

#### Agricultural Holding

Efficiency of Agricultural operation depends to a large extent on the possession and size of the land holdings of the farmers. The size of landholding and fragmentation of fields have a close relationship with the pattern of farming land use and yields per unit area. The fragmentation of holdings is a great obstacle and one of the major deterrents to economically viable cultivation. It results in wastage of land, labour and material inputs. Table 4 shows the trend of agricultural holdings and operated area in the State from 200-2001 to 2010-11.

**Table 4: Agricultural holding and operated area in Assam**

Size class (in hect)	Number of holding			Area operated (in hectare)		
	2000-01	2005-06	2010-11	2000-01	2005-06	2010-11

Marginal (Below 1.0)	1699107	1752989	1831115	662780	760145	774796
Small (1.0-2.0)	561039	591431	496574	730513	718383	687156
Semi-Medium(2.0-4.0)	351521	317859	303528	957959	846006	817982
Medium (4.0-10.0)	95500	82933	84869	498797	425403	43732
Large (10.0 & above)	4970	4902	4137	263529	298606	271763
Total	2712137	2750114	2720223	3113578	3048543	2999070

Source: Directorate of Economics and Statistics, Assam

Table 4 depict the trend of number of holding and area between the Agricultural censuses, 2000-01, 2005-06 and 2010-11. It reveals from the Agricultural Census, 2010-11 that there were 27.2 lakh operational holdings in Assam covering an operated area of 29.99 lakh hectares as against 27.5 lakh operational holdings covering an operated area of 30.49 lakh hectares in 2005-06 and 27.1 lakh operational holdings covering an operated area of 31.1 lakh hectares in 2000-01. Thus, the agricultural operated area in the state shows decreasing trend by 3.69 percent in 2010-11 over 2000-01 which largely affected by soil erosion of ever widening Brahmaputra River, increasing urbanization, industrialization, expansion of roadways and other infrastructural development activities, conversion of agricultural land for setting up of industries as well to homestead land to accommodate the increasing population.

The disaggregated data also shows that the marginal holdings with less than one hectare of land accounted for 67.3% of the total holdings and 25.8% of the total operated area of the State in 2010-11 compared to 63.7% of the total holdings and 24.9% of the total operated area of the State in 2005-06. The small holding with size class between 1-2 hectares, shared 18.25% of the total holdings and 22.91% of the total operational area and the large holdings (10 hectares and above) constituted only 0.15 percent of the total number of holdings and 9.1 percent of the total operated area in the State in 2010-11.

### Chemical fertilisers

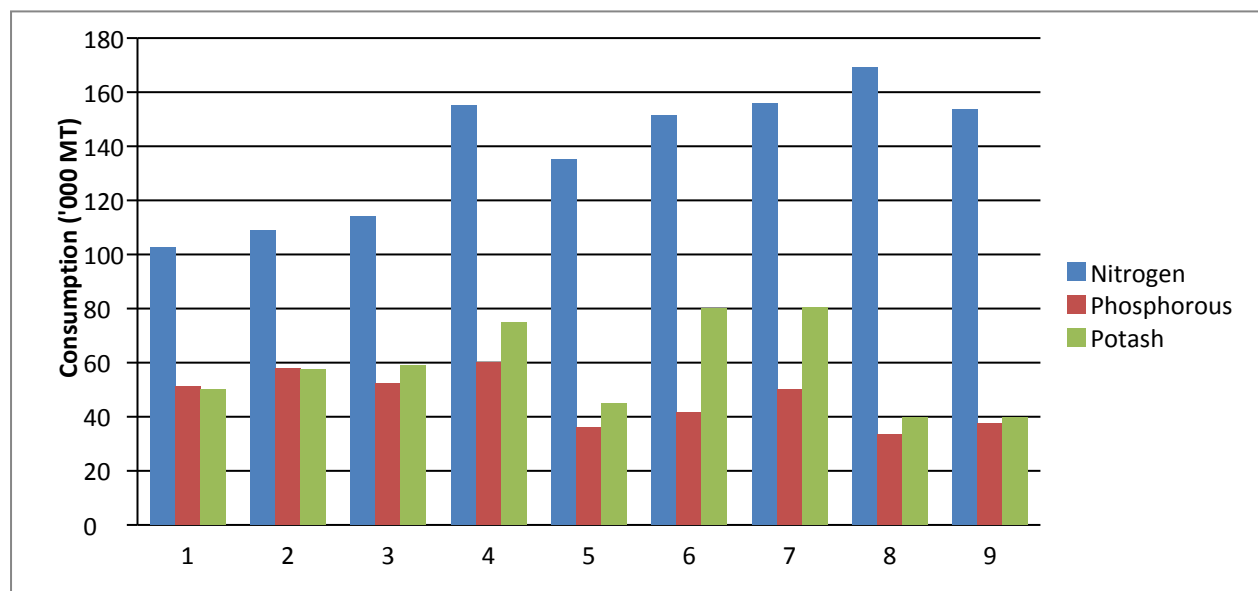
The use of fertilizer is an important ingredient in the modern technique of farming and to augment the productivity of crops thrust has been given to increase the consumption of chemical fertilizers. The consumption of fertilizer in the state is low because of low consumption during Kharif season. Farmers are reluctant to invest on fertilizer due to fear of loss for heavy rainfall and flood. Consumption of fertilizers during summer and Rabi season is low due to non-availability. The details of consumption of Chemical fertilizers in the state are presented in the Table 5.

**Table 5: Consumption of Chemical fertilisers (in '000 MT)**

Fertilizer	Year										
	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Nitrogen	102.6	109.0	114.0	135.6	129.3	155.0	135.3	151.3	155.9	169.2	153.50
Phosphorous	51.1	57.7	52.5	56.1	47.2	60.0	36.0	41.7	50.2	33.5	37.61
Potash	50.0	57.6	59.1	71.9	71.4	75.0	44.8	80.1	80.3	39.9	39.84
Total	203.7	224.3	225.7	263.6	248.0	290.0	216.1	273.0	286.4	242.6	230.95
Consumption (kg/Ha)	52.3	56.2	57.8	63.2	67.1	74.6	58.5	65.4	68.6	62.6	55.03

Source: Source: Compiled and Estimated from data collected from Directorate of Agriculture Khanapara, Assam and Economic Survey of Assam

From Table 5, it is found that the total consumption of Nitrogen, Phosphorous and Potash in the state has increased from 203.7 Thousand MT in 2006-07 to 290 Thousand MT in 2011-12. However it has decreased to 230.92 Thousand MT in 2015-16. The consumption of fertiliser in the state was 52.3 Kg/hect in 2006-07 has increased to 74.6 Kg/hect in 2011-12 and declined to 55.03 Kg/hect during 2016-17.



**Fig. 5 Consumption of Chemical Fertilisers**

**Consumption of Pesticides**

For sustainable agricultural production the key component is Integrated Pest Management (IPM). Assam has a diverse eco-system and sub-tropical climate, the crop production is associated with loss of biotic stress problem which share 20-30 percent of the yield loss. Excessive and injudicious use of chemical pesticides in the field result into development of pest resistance, pest resurgence, pest replacement and pesticides residue problem. The trend of consumption of both chemical and bio-pesticides during the last nine years is evident from Table - 5.19.

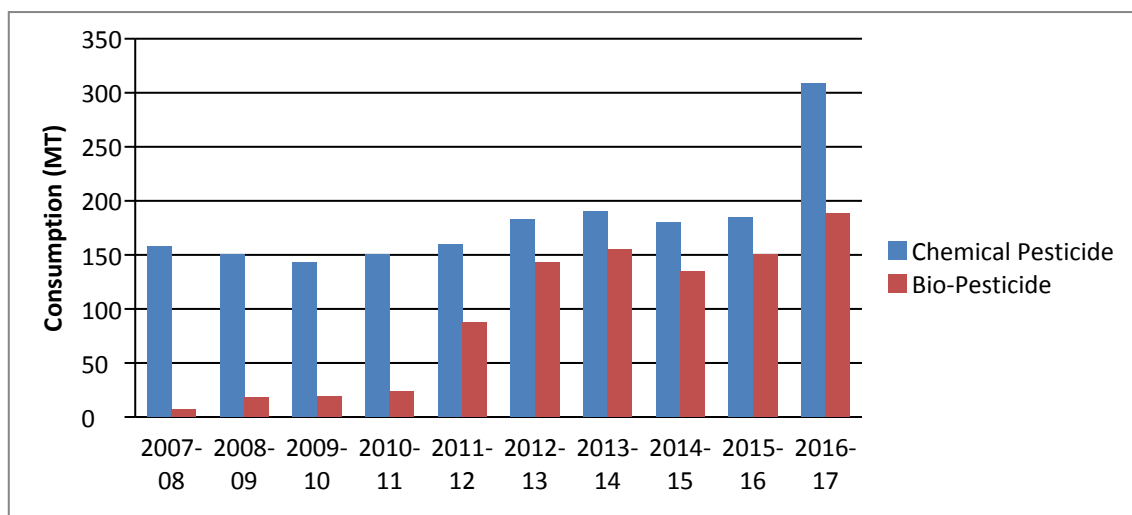
**Table 6: Pesticide Consumption (MT)**

Pesticide Consumption	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Chemical Pesticide	165.0	158.0	150.0	143.0	150.0	160.0	183.0	190.0	180.0	185.0	308.55
Bio-pesticide	-	6.7	18.0	19.0	24.0	87.0	143.0	155.0	135.0	150.0	188.00



Source: Source: Compiled and Estimated from data collected from Directorate of Agriculture Khanapara, Assam and Economic Survey of Assam

From table 7 it is evident that the consumption of chemical pesticide has increased from 165 MT in 2006-07 to 308.5 MT in 2016-17. Likewise the consumption of Bio-pesticide also reached to 188 MT in 2016-17 as against 6.7 MT in 2007 to 2008. The trend of pesticide consumption is increasing in the state especially from 2010-11 due to intensification of agriculture with the introduction of HYV, Hybrid, STW and other advance inputs which enhance the pest population dynamics and pest status.



**Fig. 6 Consumption of Pesticides**

### Status of Farm Mechanisation

Farm mechanization is a very important input for timely agricultural operation. The major constraints behind this are highly fragmented and small land holdings, which stands as an hindrance in bringing the entire farming community under high volume of mechanization. Moreover, low Farm Power provision in the State also hampers the achievement of coveted schemes of double or multiple cropping. However, an effort to boost up farm mechanization is carried on in a systematic and schematic manner. The various farm machineries and equipments during the period 2006-07 to 2014-15 are evident from the Table 5.23.

**Table 7: No. of Farm Machineries and Equipments**

Year	Tractors	Power Tillers	Power Pumps	Farm power Available (HP/hect.)
2006-07	338	2112	3994	0.54
2007-08	855	4232	9960	0.60
2008-09	1791	861	18163	0.60
2009-10	511	3782	30634	0.69
2010-11	962	3136	85506	0.90

2011-12	824	5138	12852	1.02
2012-13	588	3339	24337	1.52
2013-14	0	73	15000	-
2014-15	460	1559	60656	1.78
2015-16	0	1492	-	1.3
2016-17	0	6557	-	1.31

Source: Directorate of Agriculture, Government of Assam

From table 7 it is evident that farm mechanisation in the state is increasing over the years. The present availability of farm power in the state is 1.31 HP/hect. The growth of farm mechanisation in the state is very slow. In order to boost up the process of mechanisation, the Agriculture Department of the state have so far installed 6059 Tractors, 32281 Power Tillers, and 261102 Power Pumps.

### Irrigation

Irrigation has become one of the crucial factors in the package of inputs for attaining higher level of agricultural productivity especially after the introduction of new agricultural technology. Irrigation by way of Shallow Tube Well and Low Lift Pumps is considered to be an efficient method of water utilization for crop growth. The State has irrigation potential of 11.27 lakh hectares out of which, only 7.33 lakh hectares was under utilizable assured irrigation. Considering the uncertainties in the production of due to flood and high rainfall, the State Agriculture Department has laid greater emphasis to develop assured irrigation facilities through installation of required infrastructure (Table 8).

**Table 8: Irrigation Infrastructure created by Agriculture Department**

Component of irrigation	Year									
	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-16
Shallow Tube wells (Nos.)	2812	8190	30080	53208	141452	25704	43938	30000	55590	9274
Low Lift Pumps (Nos.)	5176	11730	6246	8060	29560	0	4736	0	5066	854

Source: Directorate of Agriculture, Government of Assam

From table 8, it is evident that the Agriculture Department of the state has given a major thrust on the development of irrigation. The Department has so far installed 400248 Shallow Tube Wells and 71428 Low Lift Pumps in the state under various schematic programmes.

### VI. Conclusion

The broad conclusion emerging from the analysis reveals that production and productivity of Agricultural produce are not consistent in the state over the years. The natural technical and socio-economic factors are responsible for the dismal growth in this sector. Fluctuation in area production and yield of the major Food Grains i.e. Rice, Wheat, and Pulses during the selected time period is not uniform. Rice is the most important

food crop occupying 93.80% of total food grain area of the state. But due to various constrains deep rooted in the process of agriculture, the production and productivity of rice could not be raised to the highest possible extent. Wheat production in the state fluctuates more in comparison to rice a showing a decreasing trend. The cultivation of pulses is getting more importance now a day and accordingly the area under operation and production is increasing. The yield rate of major food grains is witnessing frequent ups and downs due to vagaries of natural factors and inadequacy of agricultural inputs. The total area under food grain has declines over the past few years due to shifting of land of food crops to the production of vegetable and other cash crops. Although an increasing trend is observed as regard consumption of fertilisers, its consumption in terms of Nitrogen, Phosphorous and Potassium is far below the as compared to the other states of the country. Intensification of agriculture with the introduction of HYV seeds, mechanization and other advance inputs also enhanced the pest population and as a result, the consumption of pesticide is increasing in the State. Small and fragmented land holdings are one of the principal causes of low productivity as such land holdings do not facilitate economic and efficient use of modern technology. Thus it is the need of the hour for the government to formulate sound agricultural policies to encourage diversification of agricultural production and sustainable agricultural development in order to achieve the required growth in this sector.

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