Agriculture development in India:

a study on progress, performance and determinants.

Final Project for ECO 301
India in World Economy

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Introduction:

The agricultural sector is one of the most fundamental sectors of our country. It accounts for around 16% of the country's GDP.[1] This sector is a supplier of food, raw materials and fodder for a variety of industries. Indian agriculture can be seen as a critical condition for inclusive growth. The agriculture sector accounts for a very high share in employment and livelihood creation in India. The growing population of the country demands need an equivalent rise in the agricultural production.

Some of the crucial factors that affect the agricultural growth are agricultural employment, agricultural credit, agricultural land and rainfall. From the perspective of employment generation, agriculture sector is responsible for employment of over 41% work force of India.[2] The Agricultural employment provides its own share in the agricultural output produced by the country. When we talk about agriculture, it comes as no surprise that the key to a good agricultural yield lies in the rainfall patterns of a country. Rainfall in some areas is the only source of water for irrigation for farmers while in other areas, rainfall is responsible for filling up of canals, wells and other indirect mode of irrigation used by the farmers. Around 60% of the Indian farmers are dependent on rain-fed agriculture, the rain-fed agriculture covers around 50% of the agricultural land for sowing and accounts for nearly 40% of the total food produced.[3] Rainfall plays a key role in the agricultural output of a country. While the land for agricultural in India is considered to be the second largest in the world, the first largest being the United States. In general, expansion of land in agriculture happens all the time. The relationship between the area of agricultural land and agricultural output is a complex one, but we try to analyse this relationship in our analysis.

On the other hand, agricultural credit is considered to be one of the most important inputs for the growth in agricultural sector. Agricultural credit term has come into picture very late. Till 1935, the only source of credit to agriculture was from the money lenders. These money lenders charged excessively high interest rates while providing loans to the farmers. This resulted in farmers being completely dependent on such moneylenders. After the nationalisation of banks in 1969, these banks took up multiple branch expansion policies and created a network of banks which helped in providing agricultural credit on a large scale. Agricultural credit is used by small farmers and even by the large farmers to increase their income.

In this paper, we make an attempt to analyse the effects of agricultural credit, agriculture employment, agricultural land and rainfall on agricultural output. Due to limited data available, this paper restricts its study from the year 1993 to 2016.This paper is divided into 5 sections which are as follows. Section I provides a brief literature review. Section II provides the data used for the analysis. Section III states the econometric methodology used in the analysis with some descriptive data. Section IV presents the results of the empirical analysis. Section V concludes the paper.

Literature Review:

The agricultural sector is vital for developing countries like India, as this has a huge population to feed as well as a large number of people earn money from the agricultural sector also. This sector is not only about food but also concern with labours, savings, contribution to industrial goods, foreign exchange etc. So, agricultural sector development is an essential part of the development of the entire country from many perspectives. Agricultural production also depends on a lot of factors like lands, climate, labour strength, investment and so on. Just after Independence, this sector was the primary source of income for the country. Almost 50% of the total national income was coming from agriculture at that time, and 72% of the total population was engaged in agriculture or agriculture-related activities.[6] So, this can be said undoubtedly that this sector was the backbone of the Indian economy at that time. But, during the times, this contribution to the GDP has been decreased drastically. This decrease can be seen from the data available in the world bank dataset of percentage contribution from the agricultural sector to overall GDP. The share of agriculture in total income has been declined from 50 per cent in 1950 to 16 per cent in 2016-17. So, the dominancy of agriculture in the Indian economy has also been decreased. Though interestingly still over 60% population is engaged with agriculture or agriculture-related activities. Even the growth in agriculture also has been increased from 1 per cent per annum before independence to 2.6 per cent per annum after independence. Here in this project, we have taken some crucial factor for agriculture and tried to do some econometric analyses to see how these factors are affecting the total agricultural output and its contribution to the GDP.

The interaction between the performance of agriculture and climate is very crucial. In developing countries like India, the agricultural output often get affected by the whims as well as threats of nature. There are several studies which tried to explore the relationship between climate variables and agricultural production through various models such as crop simulation models and so on. In these models, crop yield change has been simulated by using an experimental functional relationship. Here the approach follows simulation, so this also includes the analysis of the possible relationship between agricultural output and probable CO_2 concentration. But this model is not enough to answer the farm level questions. Because there are a large number of possibilities for farm-level adaptation are available for the farmers. There are many studies by this model, such as Adams et al. (1990), Kane et al. (1993), Reilly et al. (1994), Rosenzweig and Parry (1994). In some studies, like Lal et al. (1996), Kumar (1998) the approach to relate the climate and agriculture is slightly different. They have used the cross-section evidence on current production in various regions. Then from that analysis, they tried to make conclusions regarding how to adapt the practices from warm areas to cooler areas if the climate becomes warmer. In this context, this is also very clearly visible that Indian agricultural is very monsoon dependent and which is inherently very risky. In our study, we attempt to measure some statistical dependencies between average rain all over this country and crop production. We have collected data for rain and overall agricultural output and percentage contribution of it to the GDP. We aim to see in what way rainfall effects crop production.

As agriculture is risk-oriented due to its dependency on climate, specifically monsoon, the credit system is a crucial part of agricultural. The method of credit has been developed as a result of seasonal needs and unpredictable fluctuations in the climate to facilitate smoothening to the consumptions of farmers throughout the year as this traditional agricultural procedure is very risky. Hence, its interest rates are also higher, and concomitant exploitation and misery often resulted. For this type of problems, this credit system is getting problematic and complicated every year. The inequality is a significant problem in this credit system which came to the notice of RBI around the 1960s. After this, the All-India Rural Review Credit Committee (chairman: B Venkatappiah, RBI 1966) has been set up to review the supply of rural credit throughout the country. After bank nationalisation, this agricultural credit had growth a lot. With all the concern and scepticism expressed, the problematic and continuous changes in institutional credit have indeed borne fruit. In the next years, the amount of institutional credit has been increased by many times, and this is available to a large part of rural small farmers also. In this context, the role of moneylenders has also been decreased a lot as a source of credit. According to a survey named All India Debt and Investment Survey, the relative shares of institutional agencies in the total cash debt of rural cultivators increased from 31.7 per cent in 1971 to 63.2 per cent in 1981 and further to 66.3 per cent in 1991. This was a great result of Bank Nationalization. Another remarkable feature for the extension of the agricultural credit system is to make an extensive, widespread network of RFIs (Rural Financial Institutions). Now after the green revolution, Indian with the help of institutional credit system has made the agricultural sector very self-sufficient with enough amount of production of almost everything throughout this country. Here we will see how this credit system has impacted the total agricultural output. We will analyse the data of the total production of every year with the credit record of every year.

Another fundamental factor in the agricultural sector is land. The knowledge about how to use the land is vital to measure the utilisation of the land in the most productive way. An inverse relationship between farm size and land productivity has become part of the conventional wisdom concerning technologically backward agrarian economies. In India, this inverse relationship was noticed for the first time in the 1950s. Reports show that this problem always exists though it is not that significant still. There are many studies which have been attempted to see the relationship with agricultural production with the amount of land in hand. It has been often seen that small farmers, being family enterprises, have a lower cost of labour than the firms with enormous wage labours. Besides this, small farmers are cultivated more intensively and produce a higher level of output per unit of land.[18] So, here in our model we have tried to incorporate the data of land which will show the dependencies of overall agricultural output on the amount of land in per year basis.

Employment in the country has a strong relationship with the agricultural sector. In India, there is a trend in people to leave agriculture after getting a higher education and move to other industries for a job and a better lifestyle with a higher and stable salary. The introduction of labour-saving technologies in agriculture is a development which can be seen in the light of the historical glory of agricultural sectors in other countries, but in India, this impacted negatively. The shift of workers to non-agricultural sectors has got influenced, and total labour-power of this sector has been decreased. From 72 per cent of the total population during independence, the labour-power has been dropped to around 60 per cent nowadays in this agricultural sector. In this context, K. S. Krishnaswamy once said, “Many changes in the production structure, institutions and policy will be required merely to ensure growth and technology change do not cause, in the immediate future, more unemployment or more inequality.”[15] Here, we collected data about unemployment and analysing it to see statically how the changes in unemployment have impacted the total agricultural output.

So, here we have tried to build a model which has analysed the available data of agricultural credit, land, rain, employment with the total agricultural output. This model will show us the econometric analysis and statistical relevances of the selected factors with the total agricultural production every year. Let’s see what we got after the empirical analysis.

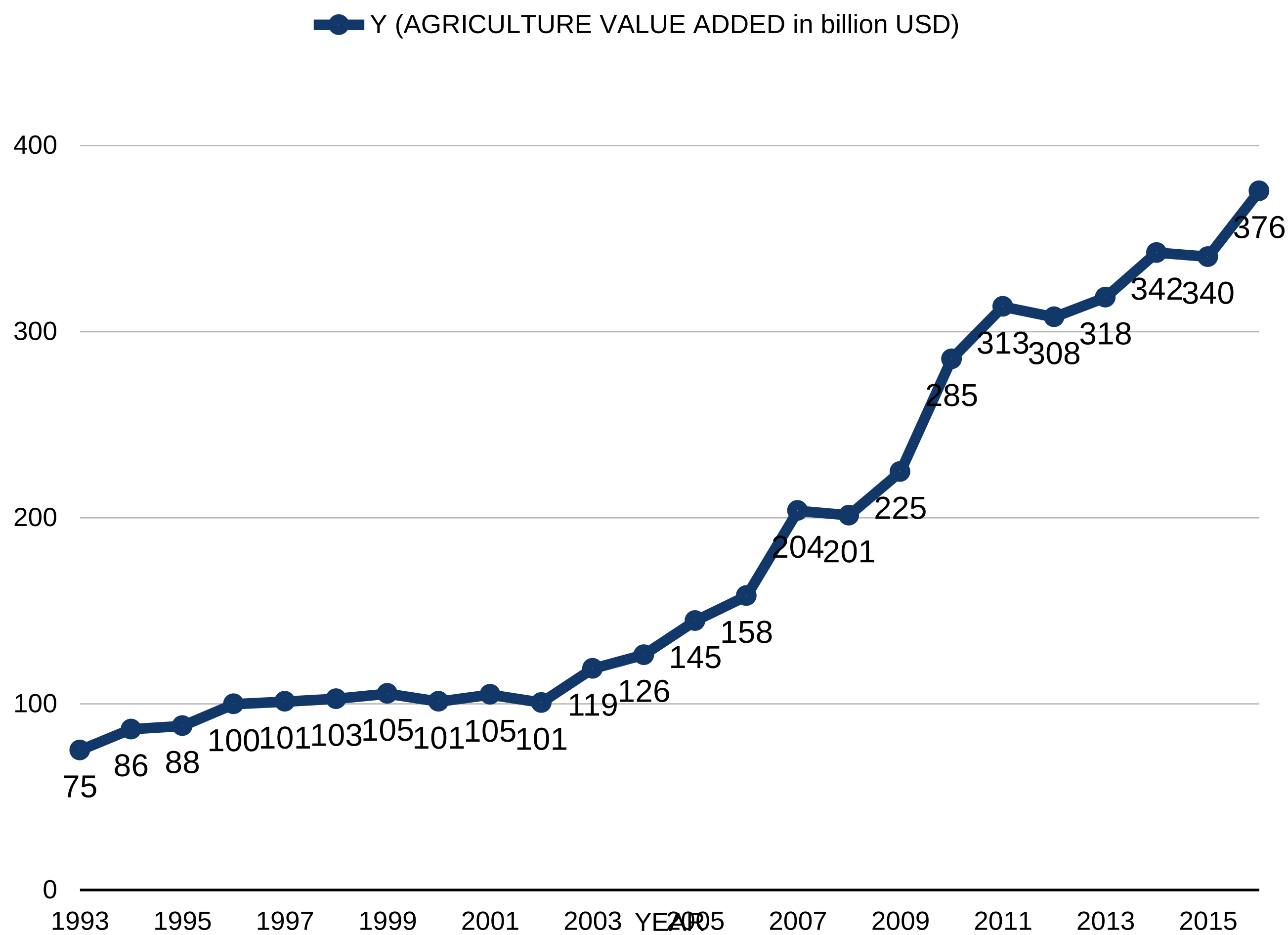
Data Description:

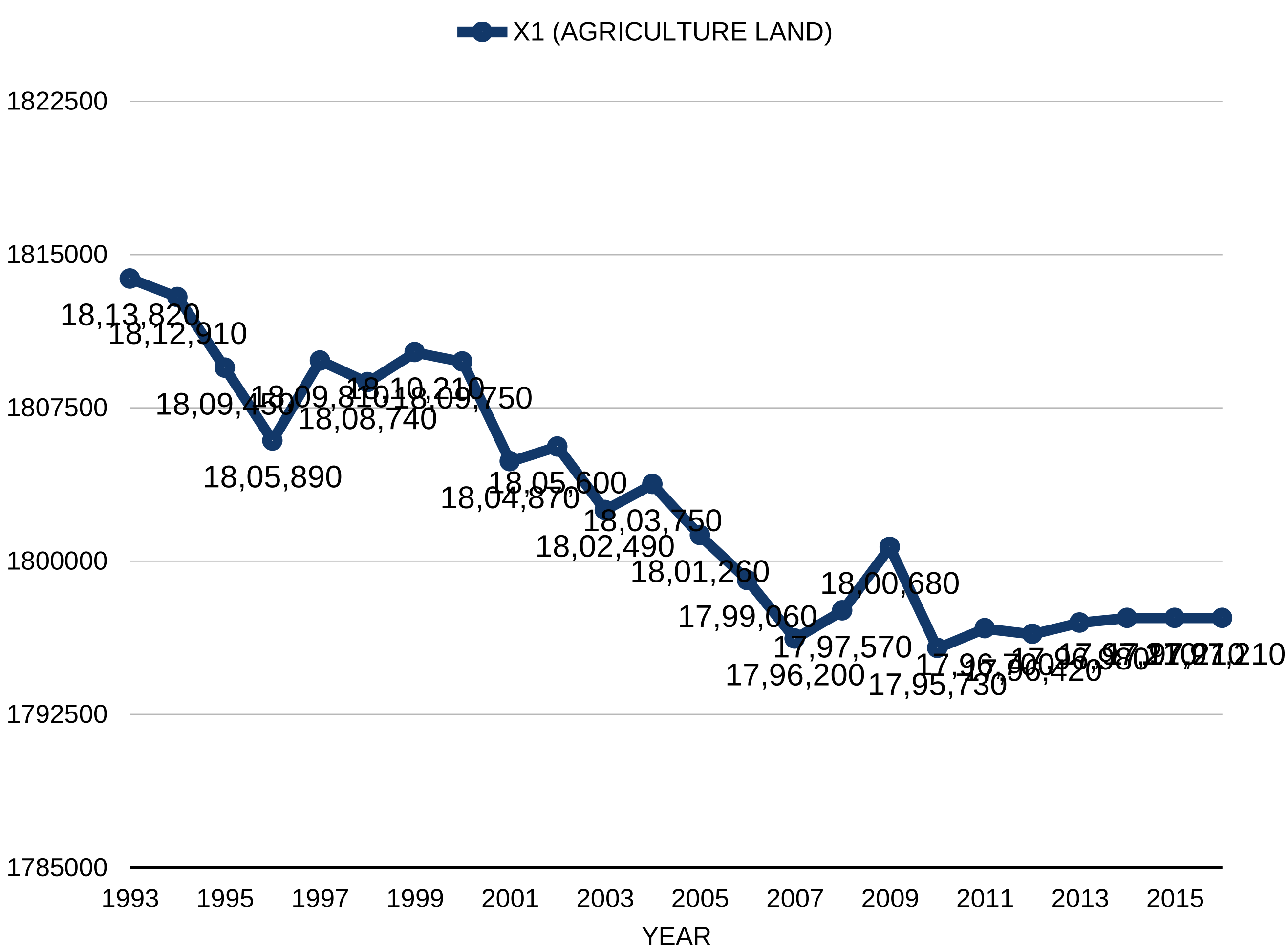
For description of trends in agriculture output we fit a multiple linear regression to estimate the effect of basic factors in agriculture-on-agriculture value added. The factors include agriculture land that refers to the share of land area that is arable, under permanent crops, and under permanent pastures and is measured in sq. km. And for this indicator we consider data for India from 1993 to 2016 whose primary source is World Bank. The other factor that we have considered is agriculture credit as whenever farmer faces a credit constraint these additional credits can increase investment and input which in turn increases the output. It is measured in rupees CRORE and the data that we have considered is of India from 1993 to 2016 and the primary source of the data is RBI. The next factor used for estimating is actual overall rainfall as it is the major factor in the growth and production of food crops. This data is measured in mm and is taken from the pdf agriculture at a glance 2018 and is measured for India from 1993 to 2016. The last factor taken into consideration is agriculture employment which is defined as persons in agriculture sector of working age who were engaged in any activity to produce goods or provide services for pay or profit, whether at work during the reference period or not at work due to temporary absence from a job, or to working-time arrangement and the agriculture sector consists of activities in agriculture, hunting, forestry and fishing. It is measured in percentage and the data is for India from 1993 to 2016 and the source of the data is World Bank. And the agriculture value added is defined as is the net output of the agriculture sector, including forestry, hunting and fishing, cultivation of crops and livestock production (after adding up all outputs and subtracting intermediate inputs) and is measured in billion U.S. dollar. For this factor we have considered data for India from 199 to 2016 and the primary source of the data is World Bank. The data used for evaluation is time series data. We have collected data from primary source for all the variables excluding rainfall. The data for rainfall is from the yearbook agriculture at a glance and we have taken that directly because we were not able to find its data elsewhere. The data statistics and plots for the given data are as follows:

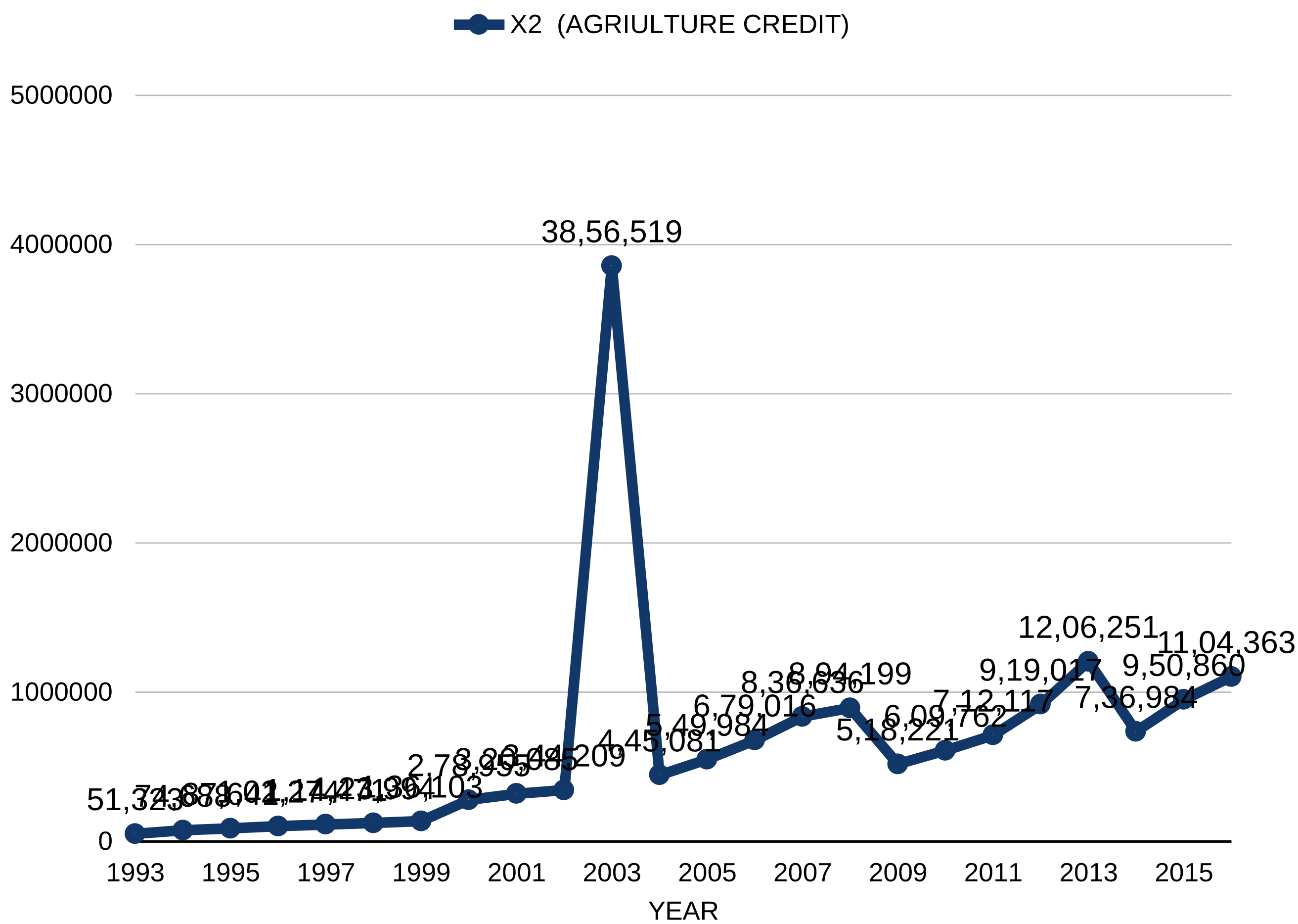
TABLE 1.1 (DATA TABLE)

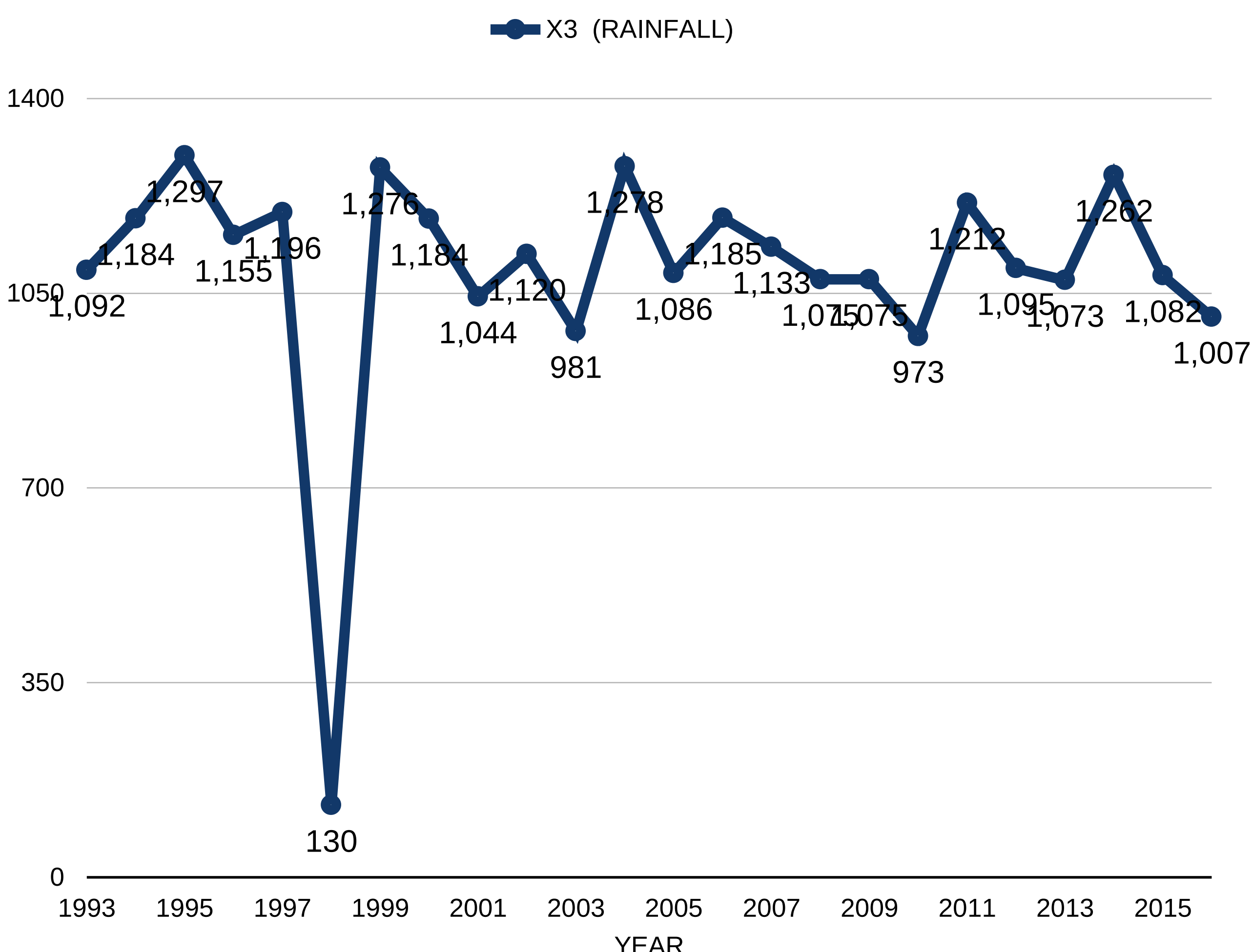
Year	Y (AGRICULTURE VALUE ADDED in billion USD)	X1 (AGRICULTURE LAND)	X2 (AGRIULTURE CREDIT)	X3 (RAINFALL)	X4 (AGRICULTURE EMPLOYMENT)
1993	75.08	18,13,820	51323	1091.6	62.27
1994	86.39	18,12,910	74688	1184.3	62.18
1995	88.11	18,09,450	87641	1297.3	61.88
1996	99.86	18,05,890	102274	1154.6	61.7
1997	101.24	18,09,810	114471	1195.5	61.05
1998	102.72	18,08,740	123994	129.5	60.67
1999	105.48	18,10,210	136103	1275.5	60.17
2000	101.22	18,09,750	278955	1183.5	59.65
2001	104.95	18,04,870	320085	1043.7	59.29
2002	100.6	18,05,600	344209	1120.2	58.71
2003	118.93	18,02,490	3856519	981.4	58.24
2004	126.33	18,03,750	445081	1278	56.73

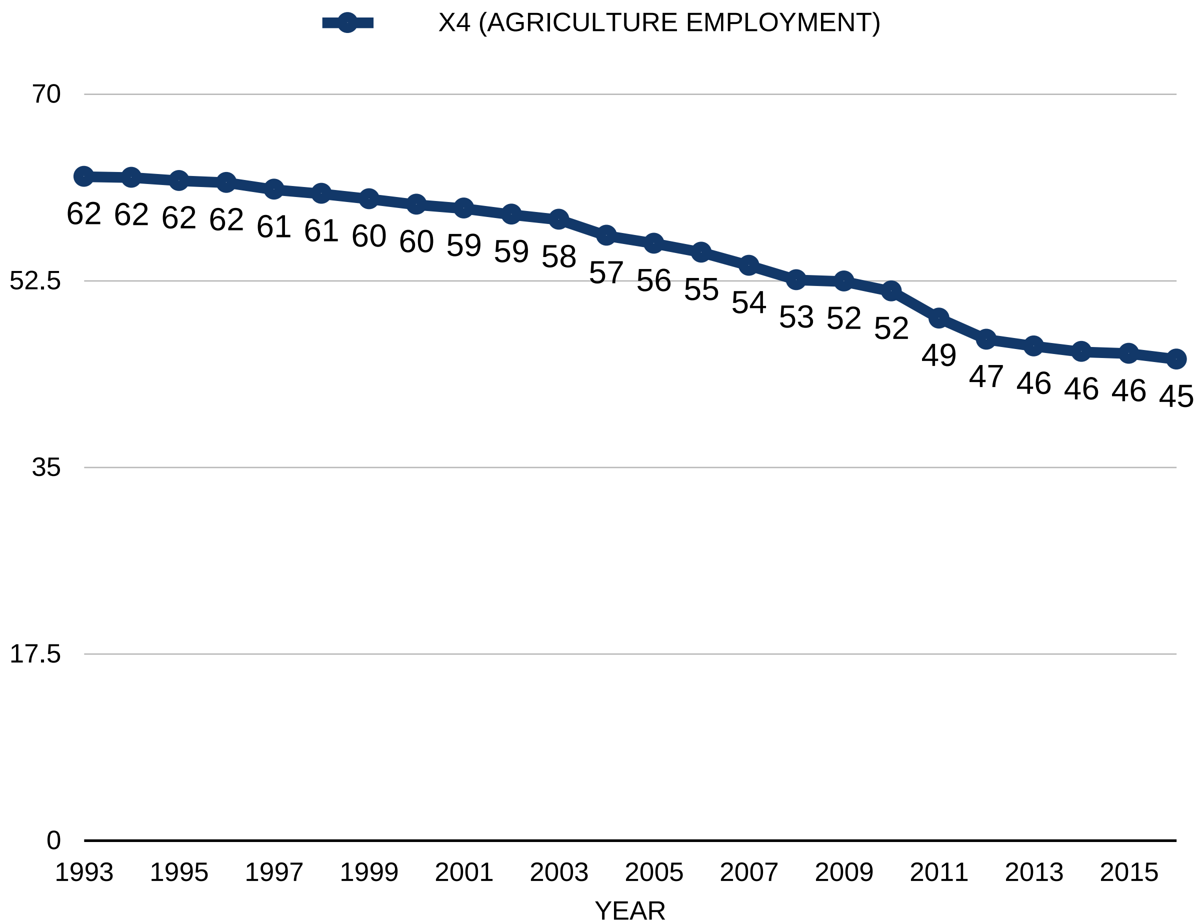
2005	144.55	18,01,260	549984	1085.9	56
2006	158.05	17,99,060	679016	1185.4	55.16
2007	203.8	17,96,200	836636	1133	53.93
2008	201.31	17,97,570	894199	1075	52.58
2009	224.69	18,00,680	518221	1075	52.45
2010	285.3	17,95,730	609762	972.8	51.51
2011	313.42	17,96,700	712117	1212.3	48.98
2012	307.8	17,96,420	919017	1094.7	47
2013	318.4	17,96,980	1206251	1073.4	46.36
2014	342.41	17,97,210	736984	1262.4	45.84
2015	340.24	17,97,210	950860	1081.8	45.67
2016	375.52	17,97,210	1104363	1007.3	45.14


Y (AGRICULTURE VALUE ADDED in billion USD)
400
300
200
100
0
75
86
88
100
101
103
105
101
105
101
119
126
145
158
204
201
225
285
313
308
318
342
340
376
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
YEAR


X1 (AGRICULTURE LAND)
1822500
1815000
1807500
1800000
1792500
1785000
18,13,820
18,12,910
18,09,450
18,05,890
18,08,740
18,09,750
18,04,870
18,05,600
18,02,490
18,03,750
18,01,260
17,99,060
17,96,200
17,97,570
18,00,680
17,95,730
17,96,420
17,97,210
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
YEAR


X2 (AGRIULTURE CREDIT)
5000000
4000000
3000000
2000000
1000000
0
38,56,519
12,06,251
11,04,363
9,50,860
7,36,984
9,19,017
5,18,221
51,323
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
YEAR


X3 (RAINFALL)
1400
1050
700
350
0
1,092
1,184
1,297
1,155
1,196
130
1,276
1,184
1,044
1,120
981
1,278
1,086
1,185
1,133
973
1,212
1,095
1,073
1,262
1,082
1,007
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
YEAR



Empirical Analysis:

The study presents an empirical investigation into the relation between basic factor in agriculture and agriculture value added. With the objective of identifying the role of basic agriculture factor in agriculture output the regression is performed with agriculture added value as the dependent variable and agriculture land, agriculture credit, actual overall rainfall and agriculture employment as the regressors.
The economic form of the model is

$$agr\_val\_ad = b_0 + b_1 agr\_ld + b_2 agr\_crd + b_3 rain\_fl + b_4 agr\_emp + u \qquad (1)$$

agr_val_ad stands for agriculture added value, agr_ld stands for agriculture land, agr_crd stands for agriculture credit, rain_fl stands for rainfall (actual overall rainfall) and agr_emp stands for agriculture employment.
Where b_0 is a constant, b_1 , b_2 , b_3 , b_4 are parameters to be estimated and u is the error term.
Firstly the correlation between the variables suggests whether the variables are related or not.

	years	agr_val_ad	agr_ld	agr_crd	rain_fl	agr_emp
years	1.00	0.94	-0.93	0.39	0.04	-0.98
agr_val_ad	0.94	1.00	-0.85	0.28	0.04	-0.98
agr_ld	-0.93	-0.85	1.00	-0.43	-0.03	0.88
agr_crd	0.39	0.28	-0.43	1.00	-0.07	-0.33
rain_fl	0.04	0.04	-0.03	-0.07	1.00	-0.06
agr_emp	-0.98	-0.98	0.88	-0.33	-0.06	1.00

In the above the degree of linear relationship between two variables I measured by Karl Pearson's correlation. So analyzing the above table suggests that agriculture land is negatively correlated with agriculture value added and agriculture employment is positively correlated with agriculture value added. While all the other factors does not seem to have a significant relation with agriculture value added.
Now finding the p-values for correlation coefficient between the variables.

n= 24

P

	years	agr_val_ad	agr_ld	agr_crd	rain_fl	agr_emp
years		0.0000	0.0000	0.0588	0.8576	0.0000
agr_val_ad	0.0000		0.0000	0.1870	0.8603	0.0000
agr_ld	0.0000	0.0000		0.0350	0.8779	0.0000
agr_crd	0.0588	0.1870	0.0350		0.7431	0.1161
rain_fl	0.8576	0.8603	0.8779	0.7431		0.7815
agr_emp	0.0000	0.0000	0.0000	0.1161	0.7815	

Analyzing the above table it’s clear that the p-values for correlation coefficient between agriculture land and agriculture value added is 0.0000 and so it is less than 0.05, looking at 95% confidence interval that means here we will not accept the null hypothesis and there is significant correlation between the two. Similarly for agriculture employment p-value is 0.0000 and so here also will not accept the null hypothesis and thus there is significant correlation between agriculture value added and agriculture employment.
But the p-value for correlation coefficient between agriculture value added and agriculture credit is 0.1870 and is greater than 0.05, looking at 95% confidence interval that means here we accept the null hypothesis and so there is no correlation between the two. And But the p-value for correlation coefficient between agriculture value added and actual overall rainfall is 0.8603 and is greater than 0.05, looking at 95% confidence interval that means here we accept the null hypothesis and so there is no correlation between the two.

Now fitting the multiple linear regression, from (1)

```
Coefficients:
(Intercept)       agr_ld      agr_crd      rain_fl
 -9.009e+02    1.156e-03   -5.443e-06   -1.166e-02
    agr_emp
 -1.783e+01
```

The model is:
Agr_val_ad = -9.009e+02*agr_ld + 1.156e-03*agr_crd + -1.166e-02*rain_fl + -1.783e+01*agr_emp

For summary of the table,

```
Residuals:
    Min      1Q  Median      3Q     Max
-29.544 -12.677  -1.236  12.965  42.965

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -9.009e+02  2.816e+03  -0.320    0.753
agr_ld       1.156e-03  1.602e-03   0.722    0.479
agr_crd     -5.443e-06  6.240e-06  -0.872    0.394
rain_fl     -1.166e-02  1.918e-02  -0.608    0.551
agr_emp     -1.783e+01  1.529e+00 -11.663 4.19e-10 ***
---
Signif. codes:
0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 20.53 on 19 degrees of freedom
Multiple R-squared:  0.9661,    Adjusted R-squared:  0.9589
F-statistic: 135.3 on 4 and 19 DF,  p-value: 1.115e-13
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Multiple R-squared: 0.9661, Adjusted R-squared: 0.9589
F-statistic: 135.3 on 4 and 19 DF, p-value: 1.115e-13

As it is clear from the above that pr(>|t|) is less than 0.05 only for agriculture employment so for this we will not accept the null hypothesis and this correlation between them is significant and all others are not significant.
The residual standard error has value 20.53 so this much deviation is present in the residual terms from its mean. Now as we have regressed multi linear regression so we will see adjusted R-squared rather than multiple R-squared as multiple R-squared always increases even if the regressor is irrelevant but this is not the case with adjusted R-squared.

Now lastly analyzing the f-statistic the p-value is 1.115e-13 which is less than 0.05 so overall the model is significant.

Discussion:

The analysis demonstrates that the overall model is significant but the individual p-value states that only agriculture employment has a significant correlation among all the regressors. Also, the multiple R^2 is 0.9589 which means that about 95% variation in agricultural output is explained by changes in agricultural land, agricultural employment, agricultural credit, and rainfall. The independent p-value calculated initially in the regression suggested that agriculture employment, agriculture land and agriculture credit had a significant correlation but after multiple regression fit the p-value stated that only agriculture employment has a significant correlation with the output so it means there isn't a LINEAR relationship between the other regressors, but there might be another type of functional relationship (for example, quadratic or exponential) which analysis has not been able to cover. Some of the conclusions from the empirical analysis are:

b_1= -9.009e+02 is the slope for agricultural land, this is the expected decrease in agricultural output corresponding to 1 sq.km increase in agricultural land when other independent variables do not change.

b_2= 1.156e-03 is the slope for agricultural credit, this is the expected increase in agricultural output corresponding to 1 crore increase in agricultural credit when other independent variables do not change.

b_3= -1.166e-02 is the slope for rainfall, this is the expected decrease in agricultural output corresponding to a 1mm increase in rainfall when other independent variables do not change.

b_4= -1.783e+01 is the slope for agricultural employment, this is the expected decrease in agricultural output corresponding to 1 percent increase in agricultural employment when other independent variables do not change.
This indicates that the total agricultural labor force in rural areas is more than required.

During the analysis we faced many limitations, some of which are:
Less availability of data because of which we were able to analyze data for only 23 years (1993-2016). We were expecting a significant impact of rainfall on agriculture output but the analysis proved otherwise. We were also expecting the coefficient of agriculture

employment to turn out positive but it wasn’t the case which states that for betterment of agriculture we do not need more employment but we need more technology.

Conclusions:

From the above discussions and empirical analysis, we can see that the land and employment have a statistical impact on total agricultural output. This shows us higher the land amount higher will be total output. Employment data has a negative effect on the total production of agriculture, i.e., higher the employment lower the entire production. One of the main reasons behind this is the traditional way of farming in India. The lack of manpower easily can be recovered with the help of technologies and scientific way to do farming. With the use of new agricultural technologies, this negative impact of employment on total production can be overcome easily. Thirdly, there is no such impact of rain on the total output according to our model. From here we can say that a large part of rural India is not dependent on rainwater anymore for agriculture. This is a result of all those dams and water reserves throughout the country. Farmers need rely fully for the water resource used in crop production. At last, we got a minimal amount of positive correlation between institutional credit and total agricultural production. The amount of credit has been increased every year, but still, this has no such effect in the total output produced in the analysis period of 1993 to 2016. This refers that the farmers still depend on the local money lenders for credits, and the reason behind this is the system of credit still have a lot of problems and complexity. Some farmers prefer contract farming for some specific crops, so they also don’t need institutional credit. So, we can conclude with the remark that from the model we can clearly see the India needs better credit system, more implement of agricultural technologies with better equipment and more land for cultivation.

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