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Economics behind Potato Production-with Special Reference to Jalpaiguri District of West Bengal

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Abstract: The fourth largest food crop of the world in terms of the production (after rice, wheat and maize) is potato. It is also a good source of nutrients, minerals and vitamins and carry very low amount of calories. An average potato consists of 80% water and 20% solid matter. Potato is known by different names in different nations. In Spain it is called 'Patata', in France it is termed as 'Pomme de terre' in Netherland, it is known by 'aardappel'. In India Potato is called mostly by 'alu' or 'aloo', in Gujarati it is called 'bataka'. At present China and India together produces nearly 40% of the world's total potatoes. This paper tries to through some lights on the cost of production, price and marketing channels of potato in Jalpaiguri Sadar Block. This paper is based on both primary and secondary data. Primary data is collected through convenience sampling. The secondary information is collected through office of the Agriculture, Jalpaiguri, and Statistical Hand book of Jalpaiguri district. Regarding methodology simple table, chart, SAGR Simple Average Growth rate, CAGR Cumulative Average Growth Rate, ANOVA, Turkey's multiple comparison method, Correlation matrix etc techniques are applied in this study.

Introduction

The potato was originally believed to have been domesticated independently in multiple locations, (Madison,2005), but later genetic testing of the wide variety of cultivars and wild species proved a single origin for potatoes in the area of present-day southern Peru and extreme northwestern Bolivia where they were domesticated approximately 7,000–10,000 years ago,(*Spooner, David M.; McLean, Karen; Ramsay, Gavin; Waugh, Robbie; Bryan, Glenn J. September 2005).* There are now over a thousand different types of potatoes,(*Office of International Affairs (1989).* Over 99% of the presently cultivated potatoes worldwide came from varieties that originated in the south-central Chile, which have displaced formerly popular varieties from the Andes (*Miller, N, and Ames, M. and Spooner, D. M. 2008).*

In Europe historians think that sailors returning from the Andes to Spain with silver presumably brought maize and potatoes for their own food on the trip in some years before the end of the 16th century,(*Ames, Mercedes; Spooner, David (2008).* So, potatoes were introduced to Europe in the second half of the 16th

century by the Spanish. However, the local importance of the potato is variable and changing rapidly. It remains an essential crop in Europe (especially eastern and central Europe), where per capita production is still the highest in the world, but the most rapid expansion over the past few decades has occurred in southern and eastern Asia. It is also believed that potatoes entered in Africa in 1567(*Sarah C. P. Williams, 2007*) who consumed them as a vegetable rather than as a staple starch, (White, 1994*).*

The potato diffused widely after 1600, becoming a major food resource in Europe and East Asia. Following its introduction into China toward the end of the Ming dynasty. In India the Portuguese introduced potatoes, which they called 'Batata', In the early seventeenth century they cultivated it along the western coast, (Fyer 1675). British traders introduced potatoes to Bengal as a root crop, By the end of the 18th century, it was cultivated across northern hill areas of India (John Reader, 2008). Potatoes were introduced to Tibet by the 19th century through the trade route from India (*Srivastava V.C. (2008).*

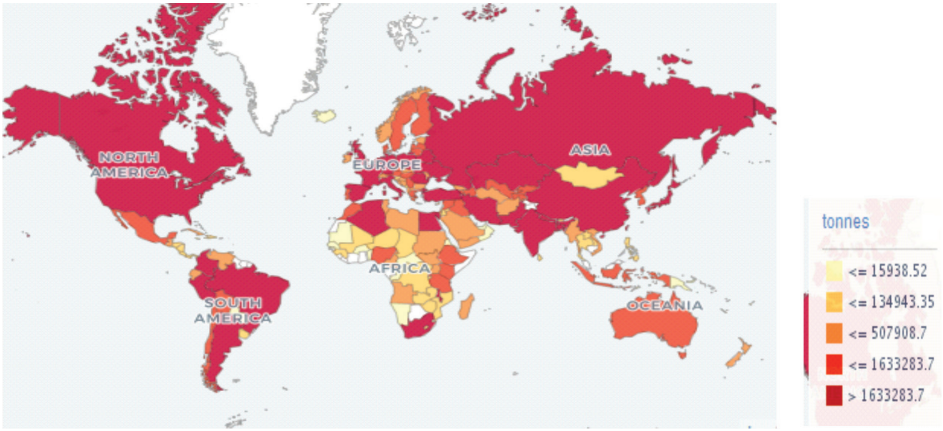
In modern times potatoes have grown in popularity due to their versatility and ability to be used for many different dishes of food. Now potato is the fourth largest food crop of the world in terms of the production after rice, wheat and maize, (*Potato Pro. 2014).* It is also a good source of nutrients, minerals and vitamins and carry very low amount of calories. An average potato consists of 80% water and 20% solid matter. Potato is known by different names in different nations. In Spain it is called 'Patata', in France it is termed as 'Pomme de terre' in Netherland, it is known by 'aardappel'. In India Potato is called mostly by 'alu' or 'aloo', in Gujarati it is called 'bataka'. At present China and India together produces nearly 40% of the world's total potatoes, (*UN Food and Agriculture Organization, Statistics Division (FAOSTAT) 2016.).*. The 16th-century English herbalist John Gerard referred to sweet potatoes as "common potatoes", and used the terms "bastard potatoes" and "Virginia potatoes" for the species we now call "potato"*(J. Simpson; E. Weiner, eds. (1989)).*

Global Production of Potatoes

According to conservative estimates, the introduction of the potato was responsible for a quarter of the growth in Old World population and urbanization between 1700 and 1900 (*Nunn, Nathan; Qian, Nancy (2011).)*

The Spanish introduced the potato to Europe in the second half of the 16th century. The staple was subsequently conveyed by European mariners to territories and ports throughout the world. The potato was slow to be adopted by distrustful European farmers, but soon enough it became an important food staple and field crop that played a major role in the European 19th century population boom (*Francis J.M. (2005).)*

Figure 1: World wide Potato Production (Tonnes) (average value from 1994-2016)

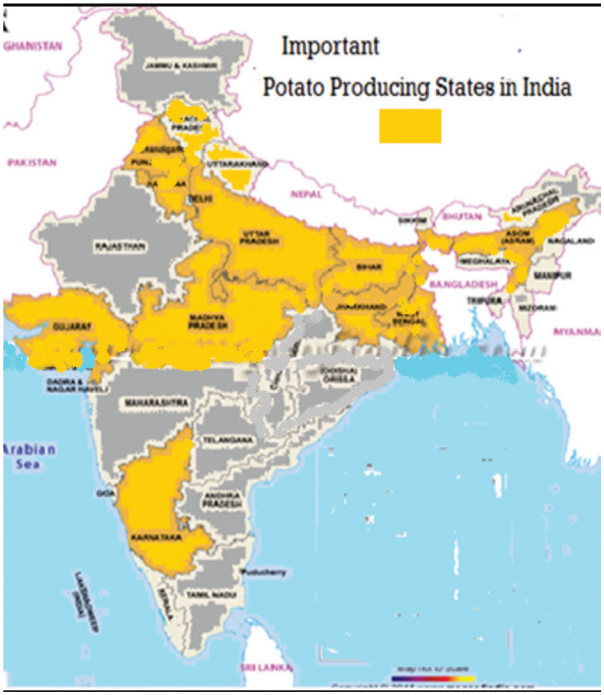


Source: United Nations Food and Agriculture Organization

From the above figure it is clear that all most all regions in the world are producing potato. The yellow portions reflect low production the orange is moderate and the dark red shows heavy production.

In India the major potato growing states are U.P, West Bengal, Punjab, Bihar Haryana, Madhya Pradesh, Gujarat and Maharashtra shown in the **figure 3** below.

Figure 3: Major Potato growing States in India



More than 80% of potato is grown in the winter season (known as Rabi crop) and the remaining percentage is known as kharip potatoes grown in Himachal Pradesh, Uttrakhund, Karnataka and Maharashtra. The details regarding seasonality, harvesting period and production of Potato crop are given in Table below:

Table 1
Seasons, Sowing & Harvesting Period And Production

(Agriculture Year: July-June) (Production in Lakh Tonnes)

Season	*Sowing Period*	*Harvesting Period*	*Five year Average Production (2012-13 to 2016-17) in India*	*Production 2016-17*	*Production 2017-18 (2nd A.E.)*
Rabi	Mid Sep. To November	December to March	409	438	453
Kharif	June	September- November	32	38	35
Kharif in hills	April-May	July- September	13	10	15
Total			454	486	503

Source: State Departments of Horticulture & Agriculture, Ministry of Farmer and welfare , Government of India

The harvesting of Rabi Potato has been completed in all Potato growing states of the country. Around 80-85% produce of Rabi potato has been stored in different cold storages of the major Potato growing states. The sowing Kharif Potato completed in Uttrakhund and Himachal Pradesh. The seed sowing of Potato in Karnataka and Maharashtra will be started in June, 2018.

The production of Potato during the year 2017-18 (Second Advance Estimate) is estimated to be 3.5% higher as compared to the previous year. However as compared to past 5 years average production, it is 10.9% higher.

Table 2
State-Wise Potato Production in the Country (Production in '000 Tonnes)

(Production in '000 Tonnes) State/Uts		*Five year Average (2012-13 to 2016-17)*	*2016-17*		*2017-18 (2nd A.E.)*	
Production		*% Share in total*	*Production*	*% Share in total*	*Production*	*% Share*
UTTAR PRADESH	14502.63	31.96	15543.00	31.98	15555.53	30.91
WEST BENGAL	10425.58	22.97	11052.60	22.74	12332.50	24.50
BIHAR	6449.06	14.21	6377.71	13.12	6377.71	12.67
GUJARAT	3015.68	6.64	3797.82	7.81	3835.79	7.62

(Production in '000 Tonnes) State/Uts		*Five year Average (2012-13 to 2016-17)*	*2016-17*		*2017-18 (2nd A.E.)*	
Production		*% Share in total*	*Production*	*% Share in total*	*Production*	*% Share*
MADHYA PRADESH	2858.30	6.30	3461.09	7.12	3537.49	7.03
PUNJAB	2278.43	5.02	2423.00	4.99	2570.67	5.11
HARYANA	769.17	1.69	896.95	1.85	1095.90	2.18
ASSAM	1039.31	2.29	777.83	1.60	1072.78	2.13
JHARKHAND	653.61	1.44	668.66	1.38	688.77	1.37
CHHATTISGARH	625.87	1.38	678.57	1.40	684.63	1.36
KARNATAKA	558.04	1.23	507.64	1.04	421.86	0.84
UTTARAKHAND	403.04	0.89	360.37	0.74	360.54	0.72
ODISHA	260.13	0.57	302.22	0.62	298.06	0.59
MAHARASHTRA	335.97	0.74	536.62	1.10	262.60	0.52
RAJASTHAN	166.93	0.37	234.55	0.48	235.00	0.47
MEGHALAYA	184.75	0.41	193.68	0.40	229.90	0.46
HIMACHAL PRADESH	210.56	0.46	202.44	0.42	200.00	0.40
TRIPURA	146.88	0.32	143.58	0.30	144.46	0.29
JAMMU & KASHMIR	127.96	0.28	130.84	0.27	132.15	0.26
SIKKIM	51.18	0.11	53.51	0.11	107.10	0.21
NAGALAND	57.74	0.13	65.59	0.13	65.02	0.13
ANDHRA PRADESH	74.51	0.16	49.11	0.10	53.09	0.11
TAMIL NADU	103.25	0.23	92.73	0.19	42.67	0.08
KERALA	7.71	0.02	5.30	0.01	4.50	0.01
MIZORAM	2.01	0.00	1.00	0.00	0.93	0.00
TELANGANA	61.82	0.14	32.78	0.07	0.30	0.00
ARUNCHAL PRADESH	0.00	1.13	0.00	0.00	0.00	0.00
OTHERS	14.70	0.03	15.40	0.03	17.05	0.03
TOTAL	45383.50	100.00	48604.57	100.00	50327.02	100.00

Source: State Departments of Horticulture & Agriculture, Government of India

Figure 4: Share in Total production of five year Average in Various states of India

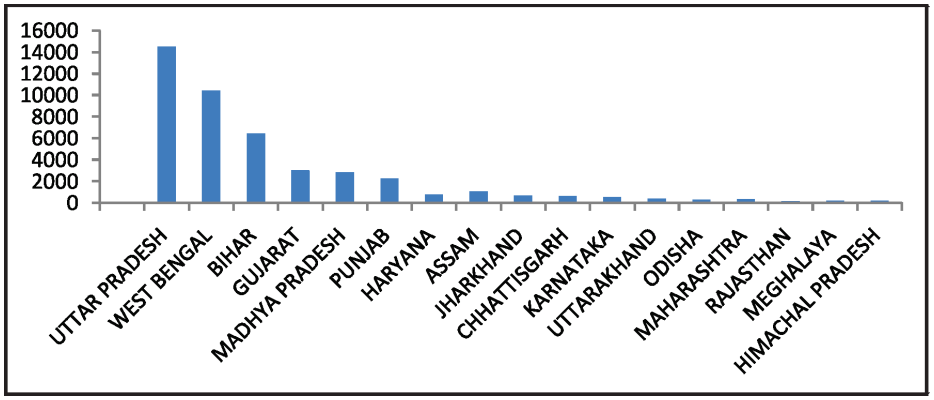


Figure 4 shows Uttar Pradesh takes the 1st place in total production, followed by West Bengal Bihar , Gujarat, Madhya Pradesh , Punjab , Haryana and Assam etc.

Monthly Arrival

The monthly all India five years (2012-2016) average arrivals of Potato in different markets of the country and for the year 2017 and 2018 (till date) are given in Table 3.

Table 3
All India Monthly Arrivals of Potato Arrivals (in '000 Tonnes)

All India Arrivals			
Month Five Year Average (2012-2016)		2017	2018
January	1204.73	1337.77	1260.88
February	1018.64	1145.00	1077.66
March	**1217.75**	**1583.36**	**1774.63**
April	941.69	1012.84	823.01
May	812.60	1010.82	767.62
June	**707.05**	**1000.35**	
July	714.04	1004.44	
August	732.09	996.40	
September	768.35	981.54	
October	753.00	1015.67	
November	794.28	1090.70	
December	1117.45	1194.33	

Source: AGMARKNET

Table 4
All India Monthly Average Wholesale Prices of Potato

(Prices in Rs/Quintal)					
Month	*2014*	*2015 2016*		*2017*	*2018*
January	1227.6	1099.4	912.1	1009.1	760.3
February	988.2	883.1	903.8	862.0	711.9
March	1145.4	783.1	962.2	745.2	968.3
April	1340.0	760.4	1274.2	756.3	1155.7
May	1491.9	888.0	1427.9	762.8	1380.6
June	1654.3	1071.9	1586.1	886.9	
July	1822.1	1048.2	1668.7	1219.6	
August	2048.8	1080.9	1829.5	1040.0	
September	**2200.9**	**1083.4**	**1806.5**	**1086.6**	
October	**2250.6**	**1096.2**	**1483.5**	**802.4**	
November	2198.7	1154.6	1612.5	866.4	
December	1610.3	963.5	944.9	825.6	

Source: AGMARKNET

Table 5
Export of Potato: Qty in MT Value in Rs. Lakh

MONTH	*2016-17*		*2017-18*	
	Qty.	*Value*	*Qty. Value*	
APRIL	13060.54	1924.50	31473.46	3911.61
MAY	19123.50	2471.52	30983.02	3784.65
JUNE	18936.36	2459.68	27445.32	3145.84
JULY	14347.84	2210.26	27818.47	3526.39
AUGUST	23914.14	5704.67	30625.01	3674.17
SEPTEMBER	13672.11	2960.82	29495.78	3157.40
OCTOBER	21212.83	5072.94	29952.88	2525.40
NOVEMBER	19431.16	4884.34	26737.30	2502.97
DECEMBER	30998.50	7160.08	17242.37	2047.22
JANUARY	30187.43	3224.38	31454.61	2727.46
FEBRUARY	19074.62	2161.27	24181.38	2418.12
MARCH	31766.48	3776.20		
TOTAL	255725.51	44010.66	307409.60	33421.23

*Source:*NHRDF

Table shows the all India five years(2012-2016) average arrivals of Potato in different markets of the country and for the year 2017 and 2018(till date). From this table it is clear that the highest arrivals is in the month of March since rabi potato comes out from land within last week of February to 1st week of March and all producers cannot get the opportunity to keep their marketable surplus in the cold storage moreover the poor/ small producers some times are bound to sale their product just after harvest to repay the loan or other obligations. The next highest arrival s in the month of December. Since the last date for keeping potato in the cold storage is 30h November every year hence the wholesalers or potato business man are bound to release their potato packets from cold storage within this point of time. During the mid time period potato comes into the market at a stable quantity say (800±50) in (,000 tones).

Table 4 shows monthly average wholesale prices of potato. From this table it is clear that average wholesale prices are low in the month of February and March due to its huge supply(for good harvesting year).this clearly reflects that the actual producers specially for small or poor farmers are not reaping the benefits of higher prices in the next successive time periods. The big prodders or wholesalers may take the advantage of high prices by controlling the supply in the market from cold storages. Table 5 shows the export quantity and value of potato export.

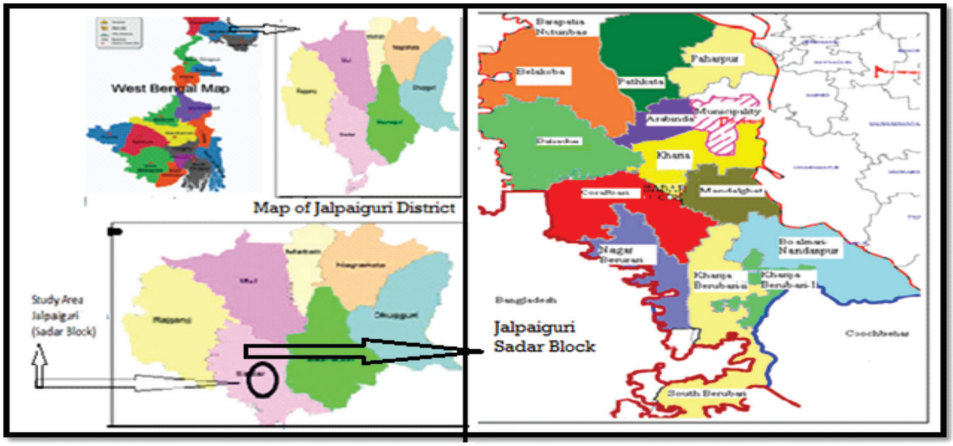
This paper tries to through some lights on the cost of production, price and marketing channels of potato in Jalpaiguri Sadar Block.

Brief outline of Jalpaiguri District

The name Jalpaiguri came from the word "jalpai" means "olive" which grew in the town and were seen even in 1900. The suffix "guri" means a place. The name as well be associated with Jalpesh, the presiding deity (Shiva) of the entire region. The economy is chiefly agrarian although the industrial belt is gradually attempting to expand its periphery. The district situated in the northern part of West Bengal has international borders with Bhutan and Bangladesh in the North and South respectively and borders with Assam and Darjeeling hills in the East, West and Northwest. The district is primarily rural with more than 80% of rural population. It has also high percentage of SC/ST population. Relatively sizeable population resides in Tea Gardens and Forest villages which are isolated and mostly inaccessible. The district is the gateway to the entire North-Eastern States and Bhutan. Having high percentage of migrated population different cultural groups (Ranjbanshi, Ravas, Totos, Metch, Santhals, Madasia and Oraons) have created a unique cultural harmony which is rarely seen in other districts of West Bengal. (Source: official website of Jalpaiguri District). Generally the potato that is produced in Jalpaiguri district known as Holland Potato or Lal alu, other types of potato (White Potato) is also produced in some parts. These two types belong

to Jyoti category potato. Generally there is two times of cultivation of potato in Jalpaiguri. One starting from end of October and Potato comes out end of December this type is known Pokhraj Potato. The seed of Pokraj potato comes from Jalandhar of Punjab. This Pokhraj potato cannot store in the cold storage, hence the production depends completely on the market. After this the production of Jyoti potato starts in Jalpaiguri.

Figure 5: Map of the Study area



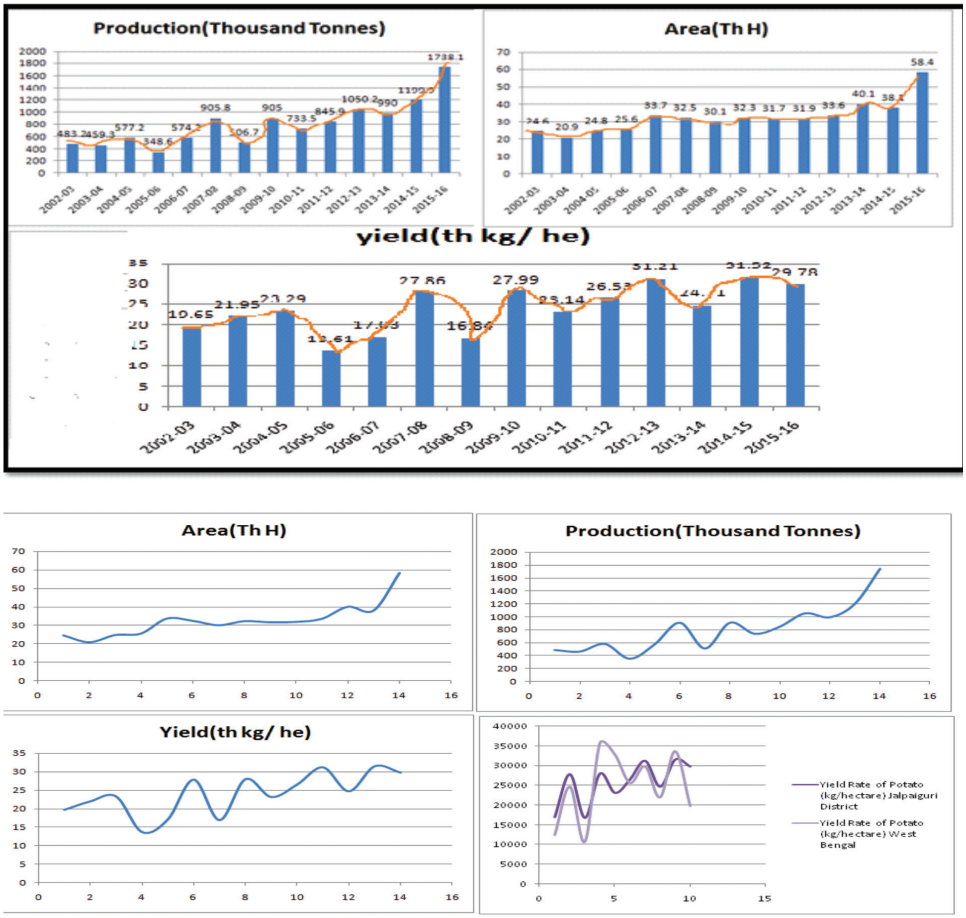
Jalpaiguri district consists of seven blocks, these are Jalpaiguri Sadar, Rajganj, Mainaguri, Dhupguri,Mal, Matiali, and Nagrakata. Among these blocks, Nagrakata, Matiali and Mal are mainly tea garden and forest based. The maximum production of Potato coming from Dhupguri, Sadar and Mainaguri blocks. The table below shows the districts production, area and Yield in various time periods. These data includes the Alipurduar (Present) district, since the data for only Jalpaiguri district is not published separately yet.

From the Figure 6 we get the following findings

1. The potato production in Jalpaiguri district from 2002-03 to 2015-16 is fluctuating up to 2010-11 , after that there is a rising trend except a slight decline in 2012-13 and beyond that period production is in increasing trend.

2. The area of land for potato cultivation is also not smooth. Up to 2006-07 it is fluctuating in nature after that it declines steadily up to 2008-09. In 2009-10 the area is increased slightly and this amount is more or less stable up to 2012-13. In 2013-14 it declines for only one year after that the area is increased steadily up to 2015-16. Generally, the price of potato depends on production, if there is huge production in one year there is some possibility of low price of potato which results decrease of profit

Figure 6: Area, Production and Yield of Potato in Jalpaiguri District, Source: (1) Directorate of Agriculture, Government of W.B, (2) B.A.E & S Government of W.B.

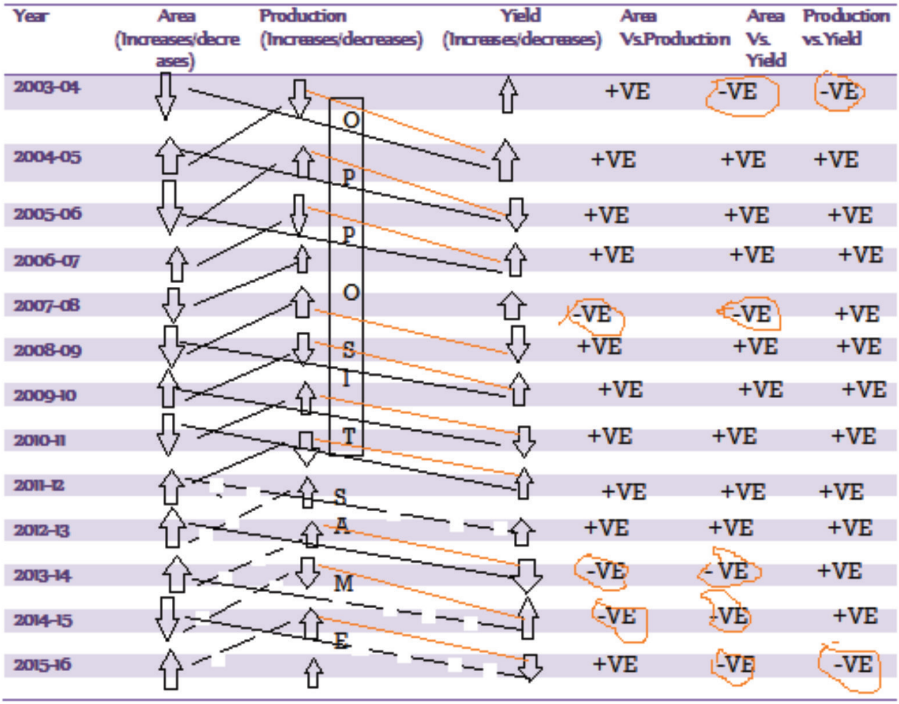


Source: author's self calculation

or sometimes loss of the farmers. Hence in the next year they may reduce the area for potato cultivation. Since production increases in 2004, 2007, and in 2009, side by it is also clear that area declines in 2005, 2008 and in 2010. But in 2013 the production declines though the area for cultivation had increased, this may be due to climatic factor.

3. The yield (thousand kg/hectare) increases from 2002-03 to 2004-05 sharply, but it declines in 2005-06, 2008-09, 2010-11, 2013-14 and 2015-16 . On the other hand after 2004-05 yield increases again in 2006-07, 200708, 2011-12, 2012-13 and 2014-15

Figure 7: The movement among area , production and yields in different time period



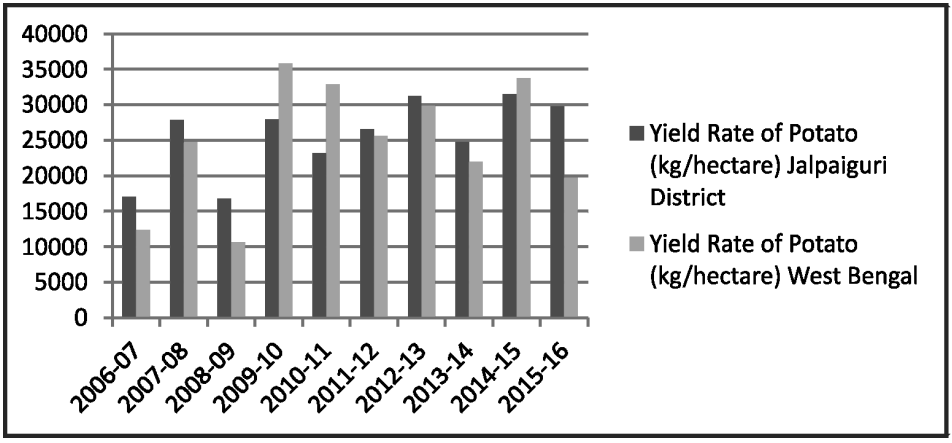
Source: author's self calculation

4. From the above figure it is clear that the movement between area of production and total production are almost similar except three years 2007-08, 2013-14 and 2014-15. Temperature and rainfall fall data should be examined during these three years.
5. The relation between area of production and yield is inconclusive. Since out of 13 years of the study period almost 5 year periods the relation shows opposite and the remaining time periods the relation is positive. It is quite natural that with the increases of area, production will increase as well as the yield also. But the figure shows even if with the increase of total production the yield rate declines in 2015-16 and in some years with the decrease of total production yield rate increases say in 2003. This also shows yield rate does not always depend on area or production. Potato yield is still gamble in weather condition in Jalpaiguri district.
6. From 2004 to 2012 the area of production is inversely related to the production of the previous year. The reason may be like this, with the increase of production may be price of Potato reduces and the farmers do not incur huge profit they might incur loss or just normal profit and

hence in the next period they reduce the area of production. But from 2012 to 2016 this relationship is direct. This may be the increase of storage capacity and possibility of making more profit. Hence with the increase of production farmers increase the area of production.

7. Another interesting thing during 2003-2011 area of production and yield rate move in opposite direction. This may be the result of less the area more intensive cultivation and vice versa. But from 2011-2016 this movement is direct. This reflects the efficiency of production. Role of government officials (KPS), improving road and other infrastructure , knowledge of gains, directions from various middleman or businessman may be important factor during these time periods.

Figure 8: A comparison of Yield rate of Potato between Jalpaiguri district and West Bengal



Source: District statistical handbook

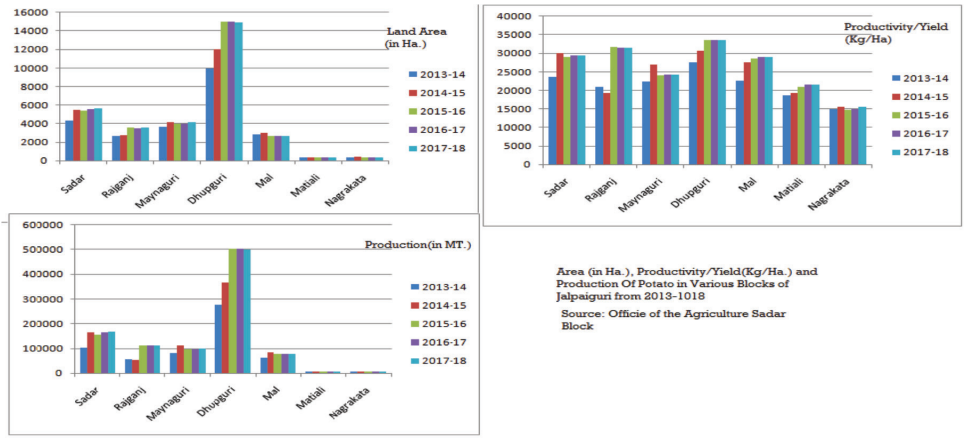
Figure 7 shows a comparison of the yield rate (Kg/Hectare) of Potato between Jalpaiguri district and the whole state West Bengal. This figure clearly shows that except few years (2009-10, 2010-11, 2014-15) in other periods the districts yield rate is higher than the whole state's yield rate. This also reflects that potato is being produced efficiently in Jalpaiguri district compared to other districts of West Bengal during the maximum periods of the study.

Table 6
Simple Average Growth Rate (SAGR) and Compound Average Growth Rate (CAGR) of Jalpaiguri District (2002-03 to 2015-16 time period)

2002-03 to 2015-16	*AREA*	*Yield/productivity*	*Production*
SAGR	10.56911	3.965551	19.97739
CAGR	6.876667	3.249842	10.34819

Table 6 shows the simple average growth and compound average growth of area, productivity and production of potato in Jalpaiguri district for the time period 2002-03 to 2015-16. The productivity is above 3% and the production is slightly more than 10%. The CAGR of area for the potato cultivation is also near about 7%. This picture shows potato cultivation in Jalpaiguri district is really playing an important role in agriculture scenario of the district, may be in near future its importance will overcome the production of rice.

Figure 9: Land Area, Productivity/yield/and production of Potato in various blocks of Jalpaiguri district from 2013-2018



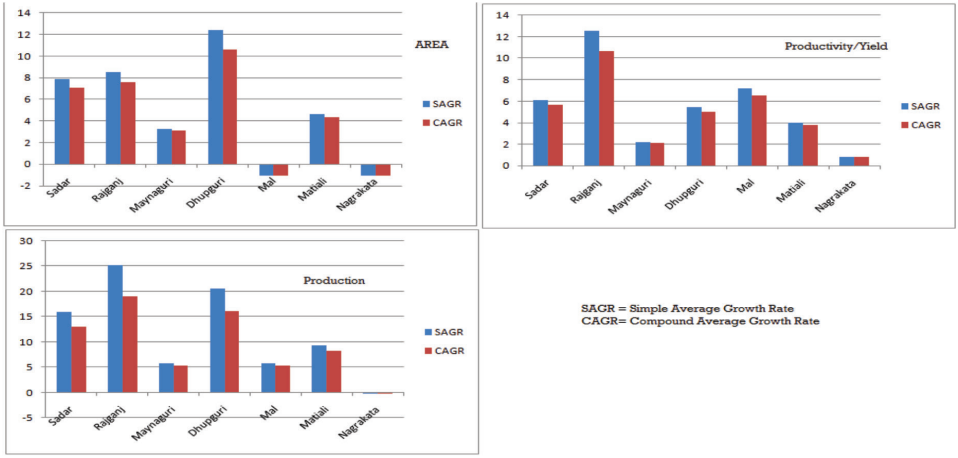
Area (in Ha.), Productivity/Yield(Kg/Ha.) and Production Of Potato in Various Blocks of Jalpaiguri from 2013-1018

Source: Officie of the Agriculture Sadar Block

From the above figure-8, it is clear that Dhupguri takes the 1st place with respect to area of production, from 2013 -2015 there is sharp increase of land area after 2015 to 2018 it is stable. Sadar block takes the 2nd position and Matiali and Nagrakata land area is minimum compared to other blocks. This may be due to the existence of many tea gardens in these blocks. The same pattern is visible in case of production also. In Dhupguri there is a sharp rise in production after 2015 the production is more or less stable. In Mal block production declines. This may be due to decrease of the availability of land for potato cultivation, since small tea growers are now increasing. But with respect to productivity the impressive picture is shown by Rajganj block. It takes 2nd position just after Dhupguri.

From figure-9 it is clear that the SAGR and CAGR shows that with respect to land area Dhupguri is highest but with respect to productivity and production the SAGR and CAGR is highest in Rajganj block where as Dhupguri takes the 2nd place. m\<al and Nagrakata block show a negative growth in area for potato cultivation.

Figure 10: Bar diagrammatic presentation of Simple Average Growth Rate and Compound Average Growth Rate of Area, Production and Yield/ Productivity of Potato in Various blocks of Jalpaiguri District (2013-17)



ANOVA Analysis: The hypothesis is that there is no mean difference in productivity or Yield/ha in different blocks of Jalpaiguri district. $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_{5=} \mu_6 = \mu_7$

Table 8
The results of the ANOVA is shown in the following table

Anova: Single Factor (Region)						
SUMMARY						
Groups	Count	Sum	Average	Variance		
Sadar	5	141700	28340	6853000		
Rajganj	5	134973	26994.6	39324061		
Maynaguri	5	121949	24389.8	2863683		
Dhupguri	5	159254	31850.8	7191603		
Mal	5	136928	27385.6	7471408		
Matiali	5	101760	20352	1898520		
Nagrakata	5	75800	15160	103000		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	9.33E+08	6	1.55E+08	**16.55936**	**4.67E-08**	**2.445259**
Within Groups	2.63E+08	28	9386468			
Total	1.2E+09	34				

From the above table it is clear that F value exceeds the critical value, hence we reject the null hypothesis. This implies there exist mean difference in productivity in various blocks. Now we apply **Tukey Multiple comparison** method to identify which block differs from rests. In multiple comparisons we have to distinguish between the individual confidence level and the family confidence level. The individual confidence level is the confidence we have that any particular confidence interval contains the difference between the corresponding population means. The family confidence level is the confidence we have that all the confidence intervals contain the difference between the corresponding population means. For this purpose we have to calculate the confidence interval for the pair of mean difference.

$$\left(\overline{x}_i - \overline{x}_J\right) \pm \frac{q_\alpha}{\sqrt{2}} .S\sqrt{\left(\frac{1}{ni}\right)+\left(\frac{1}{nj}\right)}, \quad where \ S = \sqrt{MSE}$$

Two population means different if the confidence interval for their difference does not contain 0(zero). Otherwise, do not declare the two population means different (Weiss N. 2007). The results of confidence interval for the mean difference of multiple pairs is given below.

Table 9
Confidence interval for the mean difference of multiple pairs of blocks (productivity)

	Sadar	*Rajganj*	*Maynagui*	*Dhupguri*	*Mal*	*Matiali*
Rajganj	1346 ± 6097					
Maynagui	3951 ±6097	2605 ±6097				
Dhupguri	-3510 ±6097	-4856 ±6097	-2539±6097			
Mal	955 ±6097	-391 ±6097	-2996±6097	4465 ±6097		
Matiali	7988 ± 6097	6642 ±6097	4037±6097	11498 ±6097	7033±6097	
Nagrakata	13180 ± 6097	11834 ±6097	9229±6097	16690±6097	12225±6097	5192± 6097

Table 10
Confidence interval (of the mean difference) which does not contain zero

	Sadar	*Rajganj*	*Maynagui*	*Dhupguri*	*Mal*	*Matiali*
Rajganj	No					
Maynagui	No	No				
Dhupguri	No	No	No			
Mal	No	No	No	No		
Matiali	Yes	Yes	No	Yes	Yes	
Nagrakata	Yes	Yes	Yes	Yes	Yes	No

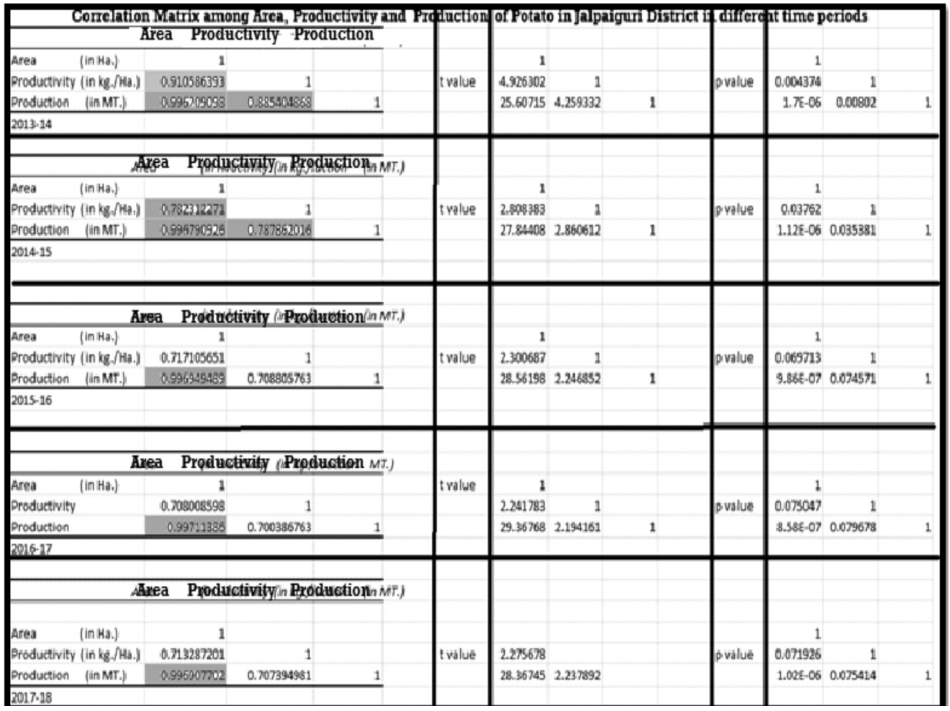
From the above table we can say that mean difference in the productivity is statistically significant and this difference is coming from Nagrakata and Matiali. Intensive research is needed to investigate the proper reasons for this difference in productivity of Potato in Nagrakata and Matiali.

Table 11
Correlation Matrix among Area, Productivity and Production of Potato in Jalpaiguri District

	Area (in Ha.)	*Productivity (in kg./Ha.)*	*Production (in MT.)*
Area (in Ha.)	1		
Productivity (in kg./Ha.)	0.9105	1	
Production (in MT.)	0.9962	0.8854	1
2013-14			
	Area (in Ha.)	*Productivity (in kg./Ha.)*	*Production (in MT.)*
Area (in Ha.)	1		
Productivity (in kg./Ha.)	0.7823	1	
Production (in MT.)	0.9967	0.78786	1
2014-15			
	Area (in Ha.)	*Productivity (in kg./Ha.)*	*Production (in MT.)*
Area (in Ha.)	1		
Productivity (in kg./Ha.)	0.7171	1	
Production (in MT.)	0.9969	0.7088	1
2015-16			
	Area (in Ha.)	*Productivity (in kg./Ha.)*	*Production (MT.)*
Area (in Ha.)	1		
Productivity(in kg./Ha.)	0.7080	1	
Production (in MT.)	0.9971	0.7003	1
2016-17			
	Area (in Ha.)	*Productivity (in kg./Ha.)*	*Production (in MT.)*
Area (in Ha.)	1		
Productivity (in kg./Ha.)	0.7132	1	
Production (in MT.)	0.9969	0.70739	1
2017-18			

Table 11 shows the correlation matrix among area, productivity and production in various blocks of Jalpaiguri District. From the above table it is clear that there is high degree of association between area and production , area and productivity. But from 2015-16 onwards there is only area and production but no significant association between area and productivity. This implies productivity is not related

Table 12
t value and p value of the correlation coefficient



Correlation Matrix among Area, Productivity and Production of Potato in Jalpaiguri District in different time periods

		Area	Productivity	Production								
Area	(in Ha.)	1				1				1		
Productivity	(in kg./Ha.)	0.910586393	1		t value	4.926302	1		p value	0.004374	1	
Production	(in MT.)	0.996709038	0.885404868	1		25.60715	4.259332	1		1.7E-06	0.00802	1
2013-14												
		Area	Productivity	Production								
Area	(in Ha.)	1				1				1		
Productivity	(in kg./Ha.)	0.782312271	1		t value	2.808383	1		p value	0.03762	1	
Production	(in MT.)	0.994790926	0.787862016	1		27.84408	2.860612	1		1.12E-06	0.035381	1
2014-15												
		Area	Productivity	Production								
Area	(in Ha.)	1				1				1		
Productivity	(in kg./Ha.)	0.717105651	1		t value	2.300687	1		p value	0.069713	1	
Production	(in MT.)	0.996349489	0.708805763	1		28.56198	2.246852	1		9.86E-07	0.074571	1
2015-16												
		Area	Productivity	Production								
Area	(in Ha.)	1				1				1		
Productivity		0.708008598	1		t value	2.241783	1		p value	0.075047	1	
Production		0.99711388	0.700386763	1		29.36768	2.194161	1		8.58E-07	0.079678	1
2016-17												
		Area	Productivity	Production								
Area	(in Ha.)	1								1		
Productivity	(in kg./Ha.)	0.713287201	1		t value	2.275678			p value	0.071926	1	
Production	(in MT.)	0.996907702	0.707394981	1		28.36745	2.237892			1.02E-06	0.075414	1
2017-18												

only with area , may be education of the family members of the producers, knowledge of the producers about the market, government's initiatives and the most important thing is weather playing important role for productivity of potato.

Table 10
Cost – Benefit analysis of Potato production (per bigha)

Cost related to Land Preparation/Bigha		*Units needed/ Bigha*	*Total cost (Rs.)*	*Remarks*
Labour	Labour /Tractor days	6 Days	1600	(2 days Culti. cost,2*200=400+4 days loter .cost,4*300=1200. So total cost for ploughing is 1600
Cost related to seed (Kachha Biz)	Bhutan made	3 Qtl.needed/ Bigha 300*30	9000	3 (own potato, Pakka Biz may also be taken which costs less but it is risky for good production).

Cost related to Land Preparation/Bigha		*Units needed/ Bigha*	*Total cost (Rs.)*	*Remarks*
Cost for Labour(female) for deriving seed tuber(-eye) from potato	Rs.50 per packet(50 kg). so for 1 bigha means 3 qtl. That is 6 packet	50*6	300	before sowing night
Labour cost for Sowing of potato seed	(5Female +2 male) labour 5*200=1000 2*300=600		1600	
cost related to Fertilizer	Lime	40 kg/2 packers@100 per packet / Bigha(2*100)	200	
	Cow-dung Fertilizer(Gobor)	½ Truck(1 trolly)	3000	
	Manure from poultry firm	10 bag/ bigha,10*150	1500	
	Urea	1packet(45 kg)/Bigha	300	
	Potash	1 packet(50 kg)	650	
	Phosphate	1 packet	400	
	10-26	2 packets=2*1700	3400	
	Bio zyme	3 kg/bigha, 3*300	900	
	zinc	2 kg/bigha, 2*70	140	
	Sulpher	2kg/bigha, 2*100	200	
Spraying pesticides and other things	Dythine(rs.1050)+ Pesticides(rs 200)+vitamine(rs 300)+medicine(rs 200)	3kg/bigha(one time cost 150 gr/bigha, costing rs. 150.00 / bigha per use	2000	Initially once in a week, later twice per week. Roughly 15 times spraying is needed

Cost related to Land Preparation/Bigha		*Units needed/ Bigha*	*Total cost (Rs.)*	*Remarks*
Irrigation	3 hours needed per bigha. (Two times)	Rs 200/hour, 200*3*2 times	1200	After 40-45 of the sibling another round of fertilizer is imposed. This is known as chapan. After that water is needed to land for two times
Plucking ,sewing bags	11 labour needed/ bigha .Among which	5 female =5*200=1000 and 2 male =2*300=600	1600	
Total cost of production /Bigha (at the Farm level)			Rs 27990	Rs.311/packet or rs.622 per Qtl./ or rs.6.22/kg (at farm level assuming 90 Packets /45 qtl production on average per bigha)
Post production cost				
Cost for Bags(Plastic made	Rs 11*90(assuming 90 packets needed per bigha)		Rs.990	
Sewing weighting etc rs 10 per Qtl	45 qtl *rs 10		Rs.450	
Loading at field level rs 10 /Qtl	45 qtl.rs 10		Rs.450	
Transportation cost (per bigha) from farm level to cold storage gate rs.40 /qtl	45 qtl*rs40		Rs. 1800	
Unloading cost at cold storage gate rs 10 /qtl	45qtl*rs10		Rs.450	

Cost related to Land Preparation/Bigha		*Units needed/ Bigha*	*Total cost (Rs.)*	*Remarks*
Loading to chamber and unloading /qtl is rs 32	45qtl*rs32		Rs. 1440	
Cost involved from field level to cold storage gate			Rs. 5580	Rs 124 /qtl. Or rs 62 per packet
Cost in the Cold storage				
Rent rs 152/ qtl	45*152	Rs.6840		Generally three types of labour are involved in cold storage. Labour for loading /unloading of potato from truck,trolley, toto. Potato carries to the cold room, labour charge,. Drying and Grading of potato (female labour).
Insurance rs 9.70/qtl	45*9.70	Rs.436		
Drying rs 32/ qtl	45*32	Rs. 1440		
Sorting grading weight loss rs80/qtl	45*80	Rs.3600		
Total cost in the cold storage for 45 qtl/1 bigha production			Rs. 12316	
Total Cost of one bigha/45 qtl/90 packets(including cold storage cost, faced by big farmer or whole seller)		27990 + 5580 + 12316	Rs. 45,886	i.e Rs 1019.68 say Rs. 1020/qtl. Or rs 509.84 say Rs.510/ packet or Rs. 10.20/kg
On an average potato production per bigha is 90 packets or 45 qtl.				

Findings

The small farmers also engaged in forward trading that is they are taking rs 50,000 money in advance from the potato trader and instead of that they have to give them one car of potato that is 200 packets or 100 qtl. Potato. Though this incurring them loss not even the cost of production but it provides them initial money to cultivate potato more over small farmers are not getting sufficient loan for potato through their KCC (Kisan Credit Card). Generally, 30 to 50% of their production is subject to forward trading and the remaining portion they sale on the ground. Before the extraction of potato the wholesalers come from Bihar,

Assam, Andhra Pradesh, Nepal and from local market. With the help of local broker they negotiate with the farmer. In case of good demand from other states or countries the farmers get good prices from the field just after production say on average rs 80 to 85 thousand per car (200 packet/ 100 qtl.) in case of bad market demand they sale at rs. 60-65 thousand per car. The medium and big farmer and the wholesaler keep the potato in the cold storage and control its supply to keep the price stable for making profit.

Figure 13: Photographs of Sorting and Grading in a cold storage

Figure 14: Photographs of fertilizer (Urea, Biozyme), and pesticides

Some information about the cold storages

In West Bengal the total number of Cold Storage Units is 575. Out of these 575, near about 460 units are dedicated to storage of potatoes with a capacity

of 70 lakh metric tonnes. Annual consumption of Potatoes of West Bengal is roughly 65 lakh tonnes(including seeds). Due to increase in the cost of electricity and other expenses the cold storage owners now looking for a rent revision. To maintain eco-friendly environment and to reduce electricity cost government is also encouraging the cold storage owners to install solar power, which will reduce the operating cost. So far 10 cold storage units mainly in Midnapore , Bankura, Hoogly etc. has been initiated. However for the installation of solar power huge investment is required. Roughly to run a cold storage 200 kilo watt solar unit, rs one crore is necessary. In the absence of any subsidy of government help such installation is difficult just by using only owner's own fund.

Summary and conclusion

This paper is based on both primary and secondary data. Primary data is collected through convenience sampling. The secondary information is collected through office of the Agriculture, Jalpaiguri, and Statistical Hand book of Jalpaiguri district. Regarding methodology simple table, chart, SAGR Simple Average Growth rate, CAGR Cumulative Average Growth Rate, ANOVA, Turkey's multiple comparison method, Correlation matrix etc techniques are applied in this study. After tea especially small tea garden or growers the next important part in the field of Agriculture is potato cultivation in Jalpaiguri district. The main objective of this paper is to through some light on the various economic aspects related to potato cultivation. The first part of the paper deals with the history of potato cultivation, worldwide production and productivity , the important states in India for potato cultivation, all India monthly arrivals , export of potato etc. Next part is an introduction of the study area with its geographical map, the block wise production, area and yield or productivity. The SAGR and CAGR technique is used for each variable, which reflects an increase in the area of land for potato cultivation; even if the farmer incurs loss to enjoy higher gain they continue their production even if by increasing the area. The ANOVA analysis shows there is a mean difference in productivity/yield per hectare in different blocks of Jalpaiguri district. The Turkey's multiple comparison techniques shows Matiali and Nagrakata differs from the other blocks. May be quality of soil is responsible for this difference in productivity of these two blocks. The correlation matrix shows degree of linear association among area, productivity and production in various blocks of Jalpaiguri District. From the above table it is clear that there is high degree of association between area and production, area and productivity. But from 2015-16 onwards there is only area and production but no significant association between area and productivity. This implies productivity is not related only with area , may be education of the family members of the producers, knowledge and experience of the producers about the market, government's

initiatives and the most important thing is weather playing important role for productivity of potato. The amount of bank loan through KCC may be increased even for the small farmers to ignore the forward trading, since at present only 1 lakh is available with 4% interest for land holder of 1 acre/3 bigha. Moreover the farmers are not unionized, hence they cannot bargain jointly with the wholesaler. Rs 50,000 is the fixed rate for forward trading since last 5-6 years in Jalpaiguri district. another problem is lands are fragmented and scattered, hence sometimes farmers takes adjacent land in lease from their owner instead of rs 2000 as rent per bigha, it increases its cost of production, though instead of that he also leased out some of his own land and earns the same but the small farmers are not getting this benefit because of small size holding. Now a day's organic farming is becoming popular hence the demand for potato from Bhutan whose retail price is almost double of the local potato is also increases. Huge potato is coming from other district of west Bengal say Burdwan. All these factors keep the price of local potato stable not expected by the wholesaler. This reduces the expected profit or sometimes loss of the Aratdar or wholesaler or big farmers. The last date for keeping potato in the cold storage is 30th November, within this the wholesalers have to release all the potato.

But the recent trend is that the price in the retail market is still at a high rate. The businessmen related to potato don't want to reduce the market price (that is don't want to increase supply in a huge amount) ,since this may leadto lower price of potato in the next year. Recently the farmers are apprehensive regarding the price hike of most of the fertilizers. This will increase the cost of production of potato which may be risky to gain at least a normal profit in the next year.

References

[1] "Potato production in 2014; Region/World/Production Quantity/Crops from pick lists". UN Food and Agriculture Organization, Statistics Division (FAOSTAT). 2016. Retrieved 6 May 2017.

[2] *"The Cambridge World History of Food- Potatoes (White)". Cambridge.org. 10 June 1994. Archived from the original on 26 December 2005. Retrieved 19 December 2010.*

[3] *"The potato sector". Potato Pro. 2014. Retrieved 31 December 2017.*

[4] *Ames, M.; Spooner, D. M. (February 2008). "DNA from herbarium specimens settles a controversy about origins of the European potato". American Journal of Botany. 95 (2): 252–257. doi:10.3732/ajb.95.2.252. PMID 21632349.*

[5] *Ames, Mercedes; Spooner, David (2008). "DNA from herbarium specimens settles a controversy about origins of the European potato". American Journal of Botany. 95 (2): 252–257. doi:10.3732/ajb.95.2.252. PMID 21632349. Retrieved 28 February 2012.*

[6] David R. Harris, Gordon C. Hillman, *Foraging and Farming: The Evolution of Plant Exploitation.* Routledge, 2014 ISBN 1317598296 p496

[7] *Hijmans, RJ; Spooner, DM (2001). "Geographic distribution of wild potato species". American Journal of Botany. Botanical Society of America. 88 (11): 2101–12. doi:10.2307/3558435. JSTOR 3558435.*

[8] *J. Simpson; E. Weiner, eds. (1989). "potato, n". Oxford English Dictionary (2nd ed.). Oxford: Clarendon Press. ISBN 0-19-861186-2.*

[9] *John Michael Francis (2005). Iberia and the Americas: Culture, Politics, and History : a Multidisciplinary Encyclopedia. ABC-CLIO. p. 867. ISBN 978-1-85109-421-9.*

[10] *John Michael Francis (2005). Iberia and the Americas: Culture, Politics, and History : a Multidisciplinary Encyclopedia. ABC-CLIO. p. 867. ISBN 978-1-85109-421-9.*

[11] John Reader, *Propitious Esculent: The Potato in World History* (2008).

[12] *Miller, N (29 January 2008). "Using DNA, scientists hunt for the roots of the modern potato". American Association for the Advancement of Science. Retrieved 10 September 2008.*

[13] *Nunn, Nathan; Qian, Nancy (2011). "The Potato's Contribution to Population and Urbanization: Evidence from a Historical Experiment" (PDF). Quarterly Journal of Economics. 126 (2): 593–650.*

[14] *Office of International Affairs (1989). Lost Crops of the Incas: Little-Known Plants of the Andes with Promise for Worldwide Cultivation. nap.edu. p. 92. ISBN 030904264X.*

[15] *Sarah C. P. Williams (15 May 2007). "The Secret History of the Potato – Science NOW". sciencemag.org. Retrieved 19 December 2010.*

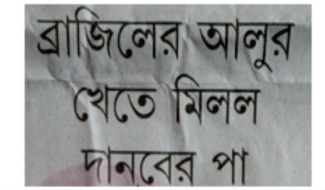
[16] *Spooner, David M.; McLean, Karen; Ramsay, Gavin; Waugh, Robbie; Bryan, Glenn J. (29 September 2005). "A single domestication for potato based on multilocus amplified fragment length polymorphism genotyping". PNAS. 102 (41): 14694–99. Bibcode:2005PNAS..10214694S. doi:10.1073/pnas.0507400102. PMC 1253605 PMID 16203994. Retrieved 10 April 2009. Lay summary.*

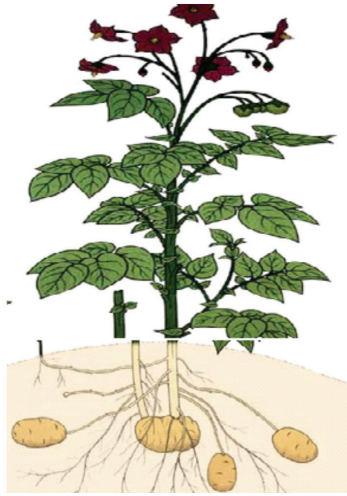
[17] *Spooner, DM; et al. (2005). "A single domestication for potato based on multilocus amplified fragment length polymorphism genotyping". PNAS. 102 (41): 14694–99. doi:10.1073/pnas.0507400102. PMC 1253605 . PMID 16203994*

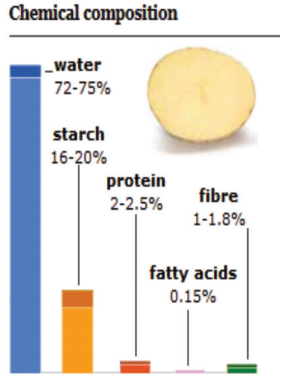
[18] University of Wisconsin-Madison, *Finding rewrites the evolutionary history of the origin of potatoes* (2005)

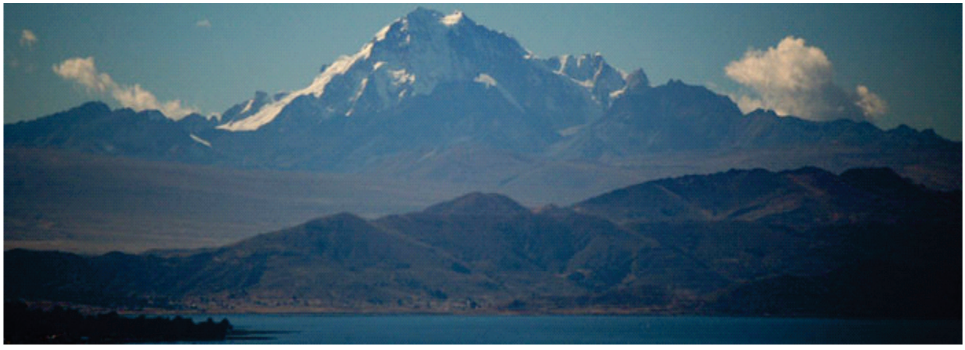
[19] *Vinod Chandra Srivastava (2008). History of Agriculture in India, Up to C. 1200 A.D. Concept Publishing Company. p. 150. ISBN 978-81-8069-521-6.*

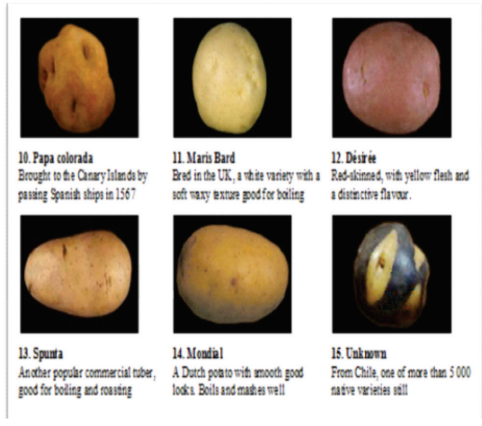
Some important Photograph are given below.

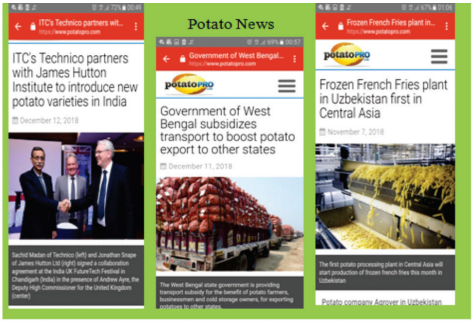








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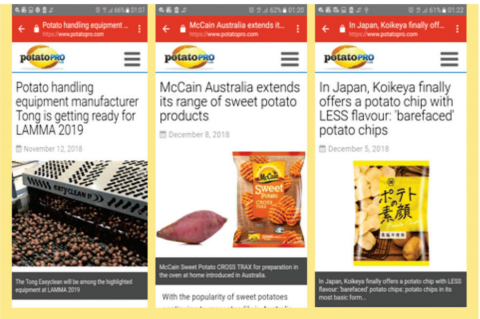
December 12, 2018
Potato News
Government of West Bengal subsidizes transport to boost potato export to other states
December 11, 2018
Frozen French Fries plant in Uzbekistan first in Central Asia
November 7, 2018


Potato handling equipment manufacturer Tong is getting ready for LAMMA 2019
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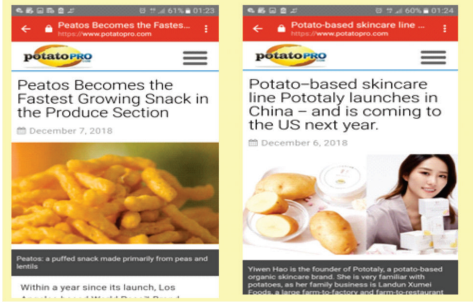
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Potato-based skincare line Pototaly launches in China – and is coming to the US next year.
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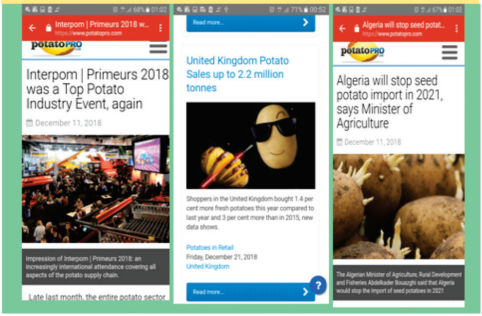
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Algeria will stop seed potato import in 2021, says Minister of Agriculture
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