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Over Utilization of Fertilizer in Potato Fields and its Impact on Soil pH: A case Study of Sarenga Block with Special Reference of Gargaria Gram Panchayat Bankura District, West Bengal, India

Kuntal Kanti Chattoraj
Assistant Professor,
Deptt.of Geography,
P.R.M.S. Mahavidyalaya
Sarenga, Bankura

Susanta Chand
Part-Time Teacher,
Deptt.of Geography,
Sonamukhi College,
Sonamukhi, Bankura

Abstract

The present paper establishes a negative relationship between over usage of fertilizer and soil pH in the study area, located Sarenga Block, Bankura District, West Bengal.

The study area exhibits very low pH value, ranging from 4.99 to 5.50. High cropping intensity and high Potato coverage mean addition of more amount of fertilizer in soil per year. Especially Potato is undertaken for the study because more amounts of fertilizers are required for this crop. Results show that there is a good negative relationship (-0.871) which is existed between potato crop coverage and soil pH.

Average excess amount of pure N, P, K is used per Hectare are 3.5 times to 4.5 times than the recommendation level. The gross value of this excess fertilizer is approximately Rs. 50,000 per Hec. This practice is harmful in both sides. In onehand, it is relating to soil health, on the otherhand, cost of production will increase. After harvesting the Potato huge amount of residual available nutrient in soil, may prove the fact. Variation is minimum regarding soil pH, soil nutrients and over all farming practice in the 24 mouzas of Gargaria G.P. Even less difference is observed between big and small marginalized farmers practice.

The paper is divided with **Three** sections. The **First Section** deals with location and general introduction of the study area, methodology and techniques adopted. **Section Two** analyse pH value of the agricultural soil and cropping intensity of the study area. Crop coverage of different mouzas of Gargaria G.P in 'Ravi Season' also incorporated in this section. Use and misuse of fertilizer and relationship with soil pH are analysed in the **Section Three.**

The study ends with a conclusion with focussing on prospect and development of agriculture in the study area.

Keywords: Cropping Intensity (C.I), Fertilizer, Gram Panchayat (G.P), Ravi Crop, Soil Nutrients.

Introduction

Potato is the most important 'Ravi' (winter) crop in West Bengal. In Sarenga Block of Bankura District, potato also cultivated in different locations. But Gargaria G.P of Sarenga Block is famous as 'Potato Belt' of south-west West Bengal. The cropping intensity is very high (249.10) in the study area due to fertile alluvium soil along the river bank of 'Kasai'.

Natural fertility of the soil is gradually changed with the passage of time due to anthropological influence. Use and misuse of fertilizer is the most important factor in this regard. It is already proved that the pH value is highly affected by fertilizer usage. In our study area at the time of potato cultivation on an average the N, P, K, fertilizers are used 3.5 times to 4.5 times more than the recommendation level. Collected soil samples after potato harvesting from each and every mouzas (24 mouzas) of Gargaria G.P show the similar type of over utilization of chemical fertilizer with a less variation. Results show that there is a negative relationship between usage of fertilizer and pH value. This type of over usage fertilizer is harmful for both sides, in onehand, it is relating to soil health, the pH value of soils going to be low (acidic) and cataion exchange capacity and role of micro-organisms are adversely affected with high fertilizer application. Everybody

knows that a lot of physical and chemical characteristics of soil are negatively related with high fertilizer usage. On the otherhand, cost of roduction is increased. Present paper tries to deals with these specific research questions.

Aim of the Study

In agricultural soil, pH of the soil is most dynamic chemical character. It may changes due to numerous influences. Among these anthropogenic influences play most vital role. Especially wrong application fertilizer in the agro field is important one. Over utilization of fertilizer is dangerous form both sides, it destroy soil health in one hand on the other hand cost of production increases.

This paper try to justify that, the soil pH as well as soil quality is how much affected by over utilization of fertilizer through a field based case study in Sarenga Block, Bankura District,West Bengal.

Review of Literature

The study is not theoretical one. The entire study is based on field observation and practical experiences where field work and laboratory testing is important. So review of literature is not as important as theoretical paper.

The paper is divided with **Three** sections.

The **First Section** deals with location and general introduction of the study area, methodology and techniques adopted.

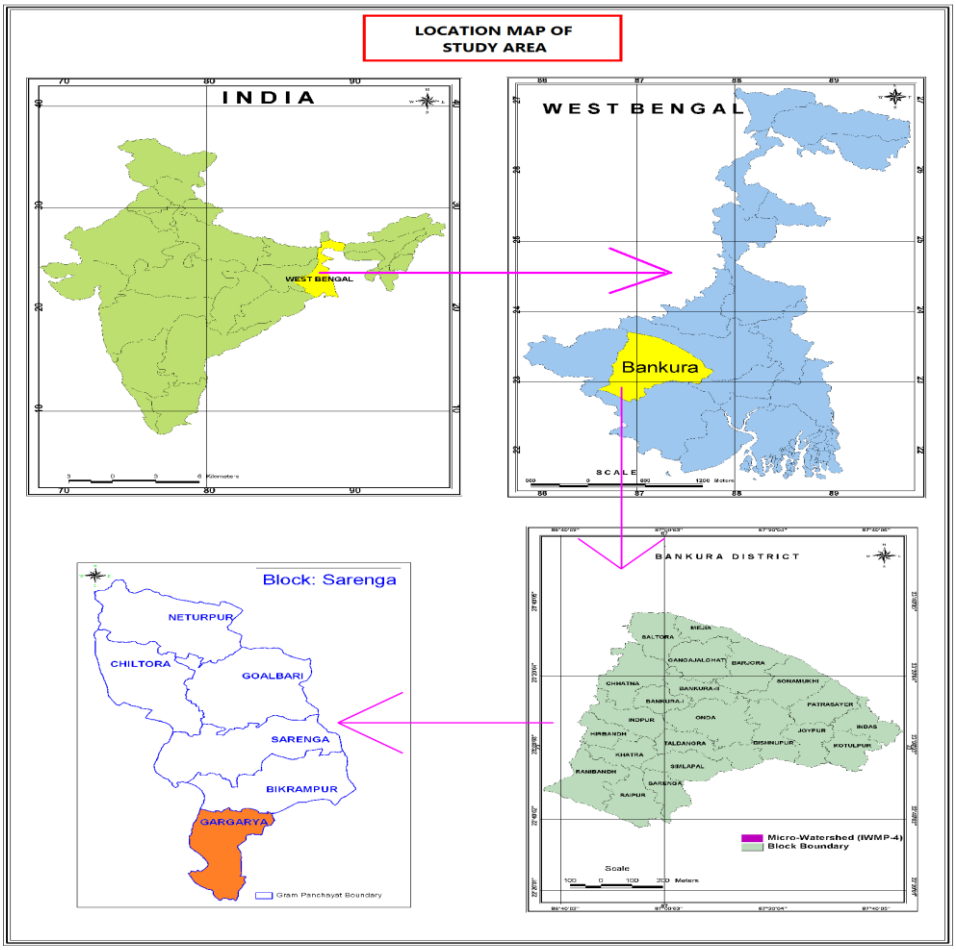
Section Two analyse, pH value of the agricultural soil and cropping intensity of the study area.

Crop coverage of different mouzas of Gargaria G.P in 'Ravi Season' also incorporated in this section.

Use and misuse of fertilizer and relationship with soil pH are analysed in the **Section Three**.

The study ends with a conclusion with focussing on prospect and development of agriculture in the study area.

Map No 1.



Section – 1

Location and General Physical Description

Sarenga Block, the region undertaken for the work, is located in the southern part of Bankura District in West Bengal between the latitude of 22.634˚ North to 22.915˚ North and longitude of 86.913˚ East to 87.10˚5 East. It covers an area of 293.51 square Kilometres. Gargaria G.P is located in the southern end of the Sarenga Block, formed the district boundary with Paschim Medinipur.(Map No-1).

The elevation of the study region (Sarenga) ranges between 60 to 80 Metres and Gargaria G.P

have the lowest elevation in the Block with a gentle slope. The soils are 'newer alluvium' type because this is an area of Kasai river flood plain.

Climate of the study region represents the typical 'Monsoon' climate. The temperature, rainfall and humidity are quite high and which is favourable for the existing agricultural practice. The summer temperature, on an average, goes up to 40° C and it falls down 10° C during winter months. During the rains temperature shows downward trend. About 85% rain fall occurs during June to September. Total annual rainfall of the region is about 135 Cm.

Methodology

The methodology of this type of work is highly significant because the entire study mainly depends on primary data.

1. Four (4) samples are collected from each mouzas. Then average is calculated from the 4 samples, for the representation of a particular mouza. The methods of data collection follow the rules of random sampling. pH value of agricultural soils of each and every samples is tested in laboratory.
2. From the collected samples residual (after harvesting potato crop) available major nutrient (N, P and K) is also tested in the Laboratory to know the misuse of fertilizer.
3. Then, Those farmers are interviewed through structured questionnaire whose farm land is undertaken for soil sample collection to know the amount of different fertilizer applied, types of fertilizer used, time of application, production of crop per Hectare, knowledge and perception relating to agriculture.
4. Secondary data from the Department of Agriculture, District Census Book is incorporated in some cases. For landscape study Survey of India Topo sheet has been taken.

Some statistical techniques used in this paper for the illustration like Standard deviation, Coefficient of variation and Correlation etc.

Section 2

The pH values of agricultural soil of Sarenga Block show that the lowest pH value existed in the Gargaria G.P. (Table-1). Twenty (20) out of twenty four (24) mouzas of Gargaria exhibit the pH value ranging between 4.00 to 4.99 and rest four mouzas are in the group of 5.00 to 5.50 and 5.51 to 6.00. So based on pH value we have selected the micro study area, Gargaria G.P. It is also interesting to note that the variation of pH value within the G.P is minimum. The S.D of the 24 mouzas is 0.51. It indicates a uniform distribution of the matter. The similar type of cropping pattern and fertilizer usage are the responsible factor in this regard because other physical or natural factor like climatic variation, parent material influence etc. does not vary in such a micro area.

Table – 1

Soil pH Value of Different Gram Panchayat (G.P) Under Sarenga Block. – 2014

PH Status of Gargaria GP							
PH Value	4.00 - 4.50	4.51 – 5.00	5.01 – 5.50	5.51 - 6.00	6.01 - 6.50	6.51 - 7.00	7.01 - 7.50
Mouzas	19	1	3	1	Nil	NIL	NIL
	PH Status of Neturpur GP						
PH Value	4.00 - 4.50	4.51 – 5.00	5.01 – 5.50	5.51 - 6.00	6.01 - 6.50	6.51 - 7.00	7.01 - 7.50
Mouzas	2	NIL	6	6	13	2	NIL
	PH Status of Bikrampur GP						
PH Value	4.00 - 4.50	4.51 – 5.00	5.01 - 5.50	5.51 - 6.00	6.01 - 6.50	6.51 - 7.00	7.01 - 7.50
Mouzas	NIL	NIL	NIL	6	11	3	2
	PH Status of Sarenga GP						
PH Value	4.00 - 4.50	4.51 – 5.00	5.01 – 5.50	5.51 - 6.00	6.01 - 6.50	6.51 - 7.00	7.01 - 7.50
Mouzas	NIL	1	1	5	17	3	1
	PH Status of Chiltore GP						
PH Value	4.00 - 4.50	4.51 – 5.00	5.01 – 5.50	5.51 - 6.00	6.01 - 6.50	6.51 - 7.00	7.01 - 7.50
Mouzas	NIL	NIL	2	4	8	10	8
	PH Status of Goalbari GP						
PH Value	4.00 - 4.50	4.51 – 5.00	5.01 – 5.50	5.51 - 6.00	6.01 - 6.50	6.51 - 7.00	7.01 - 7.50
Mouzas	NIL	NIL	8	6	14	NIL	1

Source: Laboratory Test Results

Cropping intensity of different mouzas of Gargaria G.P is very high which ranges from 200.07 to 284.42.(Table 2) High cropping intensity means higher amount of fertilizer addition in soil per year. Not only that the cropping pattern of the area is not scientific also. Through interview and questionnaire survey among the farmer it is observed that there is a general trend of over utilization of fertilizer in every crop except Sesame (Pre kharif crop). Almost all the

farmers are believed that more use of fertilizer may increase the production.

Table No – 2
Cropping Intensity of Different Mouzas in Gargaria G.P- 2014

Sl	J.L	Mouza	Kharif (Hec)	Ravi (Hec)	Pre Kharif(Hec)	Grosscropped Area(Hec)	Netcropped Area(Hec)	Cropping Intensity	Reamarks
1	355	Parulia	81	81.5808	76.3308	238.9116	84	284.42	Highest
2	295	Jamirapara	76.3	74.958	70.1688	221.4268	78	283.88	
3	345	Taldiha	91	90.71	84.2052	265.9152	94	282.89	
4	358	Bamundiha	90	86.618	81.972	258.59	92	281.08	
5	371	Thakurbari	82.5	78.8417	71.4713	232.813	83	280.50	
6	368	Belepal	116.5	110.565	100.5732	327.6382	117	280.03	
7	349	Gargaria	113	108.9384	92.34	314.2784	114	275.68	
8	372	Majuria	111	104.88	98.1882	314.0682	114	275.50	
9	366	Jukhanala	67	65.1372	55.08	187.2172	68	275.32	
10	369	Deuli	108	103.1301	94.35	305.4801	111	275.21	
11	347	Rasuna	95	92.3634	79.1132	266.4766	97	274.72	
12	354	Indabinda	79	77.99	66.5512	223.5412	82	272.61	
13	348	Jakpur	66	62.6484	55.7464	184.3948	68	271.17	
14	353	Nibra	68	63.7	56.679	188.379	70	269.11	
15	370	Pechara	67	63.8384	51.7888	182.6272	68	268.57	
16	346	Junboni	68	65.212	53.585	186.797	70	266.85	
17	365	Makarkole	63	71.9492	61.9704	196.9196	76	259.10	
18	367	Baispatra	38	45.275	33.545	116.82	50	233.64	
19	357	Chandpara	64	46.9938	34.4715	145.4653	67	217.11	
20	350	Agaya	59	54.7382	20.7272	134.4654	63	213.44	
21	356	Janapara	50	51.3569	6.6992	108.0561	53	203.88	
22	293	Dangarpara	81.5	76.35	13.6935	171.5435	85	201.82	
23	351	Ampata	78	66.2348	12.1542	156.389	78	200.50	
24	352	Sitarampur	65	58.1153	10.9329	134.0482	67	200.07	Lowest

Source: A.D.A Office, Seranga & Field Survey

The correlation value between cropping intensity and soil pH is -0.834, may support the statement.

Potato is undertaken for the study because fertilizer requirement of this crop is more compareable to any other crops. This crop is considered as most important cash crop in the area. 92.19% agricultural lands are under potato in 2014. Mouza wise crop coverage in Ravi season is tabulated below (table-3), shows a more or less uniform distribution of potato coverage among all mouzas in Gargaria G.P. Here a good negative correlation (-0.871) is observed with percentage of potato coverage and pH value of the mouza.

Table – 3 : Percentage of Ravi Crop in Different Mouzas in Gargaria G P 2014

Sl	J.L	Mouza	Potato	Musterd	Vegetables	Chilli	Others
1	355	Parulia	98.99	0.29	0.16	0.1	0.46
2	295	Jamirapara	96.23	0.24	0.14	0.11	3.28
3	345	Taldiha	94.25	1.23	1.27	1	2.25
4	358	Bamundiha	92.26	1.29	1.37	0.29	4.79
5	371	Thakurbari	90.27	0.29	2.56	1.12	5.76
6	368	Belepal	93.38	1.26	1.35	1.21	2.8
7	349	Gargaria	92.26	2.31	1.25	1.26	2.92
8	372	Majuria	95.52	1.26	1.29	1.35	0.58
9	366	Jukhanala	94.32	1.39	2.23	1.08	0.98
10	369	Deuli	92.26	2.39	2.35	0.56	2.44
11	347	Rasuna	90.69	3.25	1.36	1.45	3.25
12	354	Indabinda	96.32	1.26	0.98	0.36	1.08
13	348	Jakpur	89.26	3.69	2.36	1.35	3.34
14	353	Nibra	93.36	2.89	2.76	0.39	0.6
15	370	Pechara	88.92	2.38	2.59	1.96	4.15
16	346	Junboni	93.36	3.2	0.93	0.6	1.91
17	365	Makarkole	89.36	3.77	1.26	1.26	4.35
18	367	Baispatra	88.36	3.26	2.29	1.98	4.11
19	357	Chandpara	87.36	4.02	3.26	0.97	4.39
20	350	Agaya	87.26	4.16	2.36	1.39	4.83
21	356	Janapara	87.18	3.39	2.98	1.83	4.62

22	293	Dangarpara	88.26	2.36	2.92	1.05	5.41
23	351	Ampata	88.9	3.12	2.26	0.39	5.33
24	352	Sitarampur	87.39	3.36	2.98	0.97	5.3

Source: A.D.A Office, Sarenga and Field Survey

Section 3

In this section fertilizer usage and difference from recommendation level is measured. The recommendation of fertilizer for potato is taken from the **'Krishi Chaianyka',** publication from Bankura District agriculture Department, Government of West Bengal. Amount and type of fertilizer usage is enquired though questionnaire survey and interview.

Observation shows that the average amount of N, P, K fertilizer is used in the potato fields 300%, 350% and 350% more than the recommendation level. Every mouzas of Gargaria G.P shows the more or less similar pattern of fertilizer usage.(Table-4). Type of fertilizer used in the fields are *'Sufala 15:15:15',*(N-15, P-15, K-15) *Paras 10:26:26* (N-10, P-26, K-26) *Di* Ammonium Phosphate (N-18%, P-46%), Single Super *Phosphate* (P-16%, S-12%), *Uriea* (N-46%). From these different types of fertilizer pure amount of N,P,K is extracted and tabulated in table-4. The average monetary value in Rupees is also incorporated there. Except soil health a huge amount of monetary loss is occurred in every year for a single crop only, which may increase the production cost 32%.

Residual Available Major Nutrients

It is true that after harvesting of any crop some amount of available fertilizer is found in the soil because within the short growing season total available amount is not absorbed by plants and some amount of non-exchangeable form converted into exchangeable form. But where such a high amount of excess fertilizer is used there must be available a high amount of residual nutrient in the soil. From this point of view, all soil samples are tested in the laboratory to measure the amount of available N, P, K (Kg./Hec) to understand the misuse of these fertilizer. For the whole G.P the average amount of N, P, K are 149.43, 92.97 and 105.21 respectively (Table-5).

Some interesting observations are important in this regard. After harvesting of potato availability of N in every soil maintain a consistency but P and K nutrients show a wide variation. The Range, S.D. and C.V for N are 148.39-153.69, 9.90, 6.63 respectively whereas for P and K have the Range 63.68-109.74 and 34.19-158.60, S.D 24.35 and 26.65, C.V 26.20 and 25.33 (Table-6). These statistical values indicate the high level of dispersion of P and K nutrients in the soils of the study area.

In this connection we want to justify a relationship between the N,P,K fertilizer usage at the time of potato cultivation and residual fertilizer in the soil after harvesting of the potato. Here we observed that, there is a complete homogeneity of fertilizer usage data (Table-4&7) but residual soil nutrients show opposite trend except the availability of N. Correlation values (Table-8) between availability of N,P,K in the soil and usage of fertilizer does not show any clear relationship. Availability of P and K in the soil reflects a dispersed picture probably due to different rate of exchangeability, solubility and absorption which mainly controlled by soil pH and some others factors. There may be farther scope of research in this field. Based on this residual available nutrient the Sesame has grown after harvesting of potato without applying any fertilizer, it is a matter of pleasure because some amount is used for that crop.

Table-4.
Excess Use of Fertilizer in the Potato Field and its Monetary Value. Year-2014

Sample	Fertilizer Used	Recommendation	Over Utilised	Monetary Value (Rs.in Thousand)	Sample	Fertilizer Used	Recommendation	Over Utilised	Monetary Value (Rs. in Thousand)
1	N= 900 P= 878 K= 878	N= 200 P= 150 K= 150	N=700 P=728 K=728	N=14.0 P=20.38 K=20.38	13	N= 900 P= 878 K= 878	N= 200 P= 150 K= 150	N=700 P=728 K=728	N=14.0 P=20.38 K=20.38
2	N= 900 P= 878 K= 878	N= 200 P= 150 K= 150	N=700 P=728 K=728	N=14.0 P=20.38 K=20.38	14	N= 900 P= 878 K= 878	N= 200 P= 150 K= 150	N=700 P=728 K=728	N=14.0 P=20.38 K=20.38
3	N= 900 P= 878 K= 878	N= 200 P= 150 K= 150	N=700 P=728 K=728	N=14.0 P=20.38 K=20.38	15	N= 900 P= 878 K= 878	N= 200 P= 150 K= 150	N=700 P=728 K=728	N=14.0 P=20.38 K=20.38
4	N= 900 P= 878 K= 878	N= 200 P= 150 K= 150	N=700 P=728 K=728	N=14.0 P=20.38 K=20.38	16	N= 958 P= 880 K= 880	N= 200 P= 150 K= 150	N=758 P=730 K=730	N=15.16 P=20.44 K=20.44
5	N= 900 P= 878 K= 878	N= 200 P= 150 K= 150	N=700 P=728 K=728	N=14.0 P=20.38 K=20.38	17	N= 958 P= 880 K= 880	N= 200 P= 150 K= 150	N=758 P=730 K=730	N=15.16 P=20.44 K=20.44
6	N= 900 P= 878 K= 878	N= 200 P= 150 K= 150	N=700 P=728 K=728	N=14.0 P=20.38 K=20.38	18	N= 958 P= 880 K= 880	N= 200 P= 150 K= 150	N=758 P=730 K=730	N=15.16 P=20.44 K=20.44

7	N= 958 P= 880 K= 880	N= 200 P= 150 K= 150	N=758 P=730 K=730	N=15.16 P=20.44 K=20.44	19	N= 900 P= 878 K= 878	N= 200 P= 150 K= 150	N=700 P=728 K=728	N=14.0 P=20.38 K=20.38
8	N= 925 P= 884 K= 884	N= 200 P= 150 K= 150	N=725 P=734 K=734	N=14.50 P=20.55 K=20.55	20	N= 900 P= 878 K= 878	N= 200 P= 150 K= 150	N=700 P=728 K=728	N=14.0 P=20.38 K=20.38
9	N= 925 P= 884 K= 884	N= 200 P= 150 K= 150	N=725 P=734 K=734	N=14.50 P=20.55 K=20.55	21	N= 900 P= 878 K= 878	N= 200 P= 150 K= 150	N=700 P=728 K=728	N=14.0 P=20.38 K=20.38
10	N= 912 P= 884 K= 884	N= 200 P= 150 K= 150	N=712 P=734 K=734	N=14.24 P=20.55 K=20.55	22	N= 900 P= 878 K= 878	N= 200 P= 150 K= 150	N=700 P=728 K=728	N=14.0 P=20.38 K=20.38
11	N= 900 P= 878 K= 878	N= 200 P= 150 K= 150	N=700 P=728 K=728	N=14.0 P=20.38 K=20.38	23	N= 900 P= 878 K= 878	N= 200 P= 150 K= 150	N=700 P=728 K=728	N=14.0 P=20.38 K=20.38
12	N=945 P= 899 K= 899	N= 200 P= 150 K= 150	N=745 P=749 K=749	N=14.90 P=20.97 K=20.97	24	N= 900 P= 878 K= 878	N= 200 P= 150 K= 150	N=700 P=728 K=728	N=14.0 P=20.38 K=20.38

Table-5.
Major Nutrients (N,P,K) in the Soils after Harvesting of Potato. Year - 2015

Sample	Major Nutrients	Sample	Major Nutrients
1	N= 157.52 P= 116.72 K= 107.11	13	N= 135.16 P= 111.08 K= 124.14
2	N= 158.65 P= 131.51 K= 98.58	14	N= 149.39 P= 132.14 K= 108.52
3	N= 162.39 P= 110.88 K= 110.29	15	N= 152.26 P= 87.65 K= 101.23
4	N= 148.39 P= 63.68 K= 134.19	16	N= 159.15 P= 101.93 K= 81.20
5	N= 151.52 P= 83.86 K= 154.20	17	N= 145.36 P= 82.26 K= 76.98
6	N= 153.69 P= 109.74 K= 158.60	18	N=149.35 P= 98.39 K= 112.58
7	N= 127.35 P= 63.86 K= 71.67	19	N= 131.26 P= 119.39 K= 87.52
8	N= 152.36 P= 62.72 K= 130.13	20	N= 142.35 P= 112.64 K= 98.52
9	N= 134.58 P= 72.96 K= 112.26	21	N= 150.26 P= 118.65 K= 123.39
10	N= 148.38 P= 68.98 K= 98.48	22	N= 168.37 P= 96.38 K= 102.58
11	N= 156.26 P= 50.15 K= 110.03	23	N= 158.24 P= 76.35 K= 109.56
12	N= 148.26 P=73.22 K= 134.55	24	N= 153.26 P= 106.26 K= 78.54

Source: Lab. Testing.

Table- 6
Dispersion Statistics of Availability of N, P, K Nutrients in the Soils after Harvesting of Potato. Year-2015.

Nutrients	Mean	S.D	Range	C.V
N	149.43	9.90	148.39-153.69	6.628
P	92.97	24.35	63.68-109.74	26.20
K	105.31	26.65	34.19-158.6	25.32

Source: Authors Calculation.

Table- 7
Dispersion Statistics of Fetilizer (N, P, K) Application in the Potato Fields. Year-2014

Nutrients	Mean	S.D	Range	C.V
N	914.12	22.92	900-958	2.51
P	880.33	4.73	878-899	0.54
K	880.33	4.73	878-899	0.54

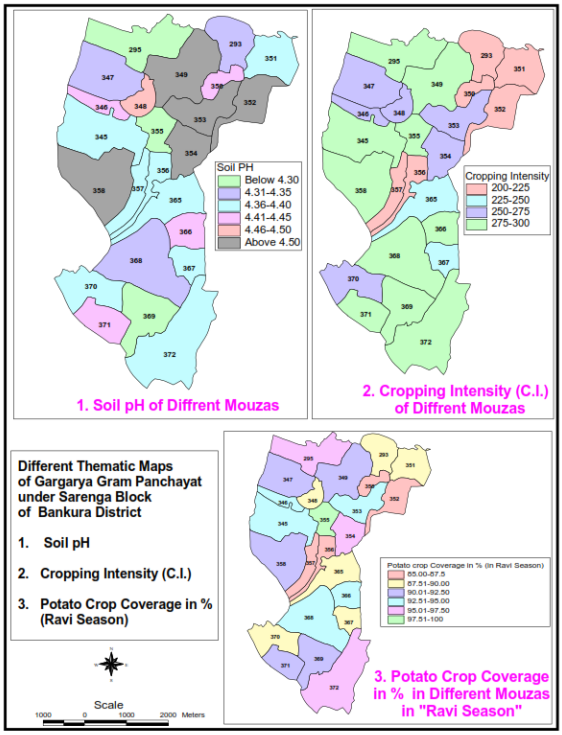
Source: Authors Calculation

Table- 8
Correlation Value (r) Between Used Fertilizer in Potato Fields and Available Nutrients After Harvesting Potato.

Variables	Correlation Value (r)
N fertilizer Used at the time of Potato cultivation and Availability of N in the soil after Potato harvesting.	-0.27
P fertilizer Used at the time of Potato cultivation and Availability of P in the soil after Potato harvesting.	-0.49
K fertilizer Used at the time of Potato cultivation and Availability of K in the soil after Potato harvesting.	0.23

Source: Authors Calculation

Map-2
Soil pH, Cropping Intensity and Potato Crop Coverage of Different Mouzas in Gargaria G.P



Conclusion

The favourable environment of Potato cultivation in South Bankura there identified some shot of gap between existing agricultural practice and modern scientific knowledge whereas the study area is considered as the best agricultural zone in southern Bankura. Fertilizer usage is not proper as per nutrient requirement of the crop which may harmful from both sides, soil quality will gradually degrade and production cost also will increase. Everyone knows the uptake of nutrients directly depends on the soil pH. Better *K* and *P* uptake is possible when the pH value is 6.5 to 7. So, in such acidic soil more amount of fertilizer generate fewer ions for uptake. In this way storage of fertilizer in soils again increase acidity and to get more effectiveness more fertilizer will be added in future. This is a dangerous cycle of pH and fertilizer application caused by faulty knowledge of farmers. It is very easy to come out from this cycle applying some chemical or physical process. Perception and practice of farming does not vary much more among the big farmers and small farmers. Though the agriculture of this region is mainly subsistence in nature but Potato is considered as an important cash crop because harvested product directly sold out from the field with a good profit (except some years). Proper knowledge regarding fertilizer applications should be supplied to the farmer's community and 'optimum fertilizer means more crop' should be proved experimentally, otherwise they do not accept the modern knowledge in place of traditional practice.

For searching a sustainable and more profitable agriculture Department of Agriculture, West Bengal Government and Researchers/NGOs should be worked together. We are hopeful because there is a great scope to develop the agricultural landscape by providing some basic infrastructural and perceptional change.

The study is not theoretical one. The entire study is based on field observation and practical experiences where field work and laboratory testing is important. So review of literature is not as important as theoretical paper.

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