

VILLAGE LEVEL ANALYSIS OF SOIL CHARACTERISTICS, AGRICULTURAL PATTERN AND ECONOMIC SIGNIFICANCE OF AGRICULTURE-A CASE STUDY OF KSHETIA VILLAGE OF PURBA BARDHAMAN DISTRICT OF WEST BENGAL

¹Dolly Gorai, ²Indrasish Mukherjee, ³Sanchita Saha

Abstract—There are so many works based on soil nutrients and agricultural pattern but only few of them are done in small spatial scale. This study tries to explain the characteristics of soil in general and its internal variability with probable reason and the agricultural pattern by explaining cropping pattern, agricultural techniques and workforce participation in agricultural sector of the study area. The temporal variability in agricultural pattern is also explained by providing necessary data. At last it also identifies major problems in agriculture of the study area in recent time and suggests some remedies.

Index Terms—Soil Characteristics, Agricultural Pattern, Village Economy

I. INTRODUCTION

Soil is a very important component of physical environment and it has regional variability in its physical and chemical properties. In a large spatial scale the variability is mainly caused by differential condition of various natural units such as climate, relief, vegetation etc. but with the reduction of spatial scale in very small unit the factors of natural environment generally becomes less significant than anthropogenic factors. In a village level variability within soil is caused by its differential use and in an agricultural region it's caused by differential agricultural techniques.

In most of the Indian villages agriculture is the dominant economic activity. The agricultural pattern of an Indian village is primarily controlled by climate and soil. Both of them play dominant roles in nature and amount of crop production. But the impact of modern technology, social conditions, government policy and regional development are also significant controller of agricultural development. Occupational structure and land utilization are also very significant factor which reflects the dependency and reliability in agriculture.

Agricultural pattern in several Indian villages have changing nature over time due to changes in agricultural technology and production. In recent time agricultural sector in India is facing some problems mainly due to some economic condition and government along with agricultural scientists are trying to find out necessary solution.

II. STUDY AREA

The study area is located within Bardhaman-I block of Purba Bardhaman district of West Bengal having an area of 114.27 hectares. Physiographically it comes under Bengal deltaic region having tropical monsoon climate. Thus it receive huge amount of rainfall in summer season. Due to suitable environment population concentration is very high with a number of 2421 people. Agriculture is the major economic activity in this region.

III. AIMS AND OBJECTIVES

The aims of the study are to understand and analyze the soil characteristics agricultural pattern and influence of agriculture on village economy of study area and to fulfill these aims it has following objectives:

- i. To understand physical and chemical properties of soil of the study area and its major controlling factors.
- ii. Understand and analyze the cropping pattern, agricultural techniques and workforce participation.
- iii. Understanding the change in workforce pattern and its probable reason.
- iv. Some major drawbacks in agriculture in recent time and suggest some remedies.

IV. METHODOLOGY

The work is based on both primary and secondary data. The analysis of soil properties is made on the basis of statistical analysis by calculating mean and coefficient of variance of primary data obtained through laboratory experiment of collected soil samples from the agricultural fields of study area to understand the overall properties and internal variability of soil. The samples are collected from 10 different agricultural fields of the study area using 'Simple Random Sampling with Replacement' and sample locations have been obtained by creating random points in the mouza map using QGIS. For the analysis of agricultural pattern secondary data obtained from Primary Census Abstract (PCA) of 2001 and 2011 are used to understand the working pattern in agricultural sector and land utilization and its change within the time period. To understand the cropping pattern and agricultural techniques a sample study has been carried out interviewing the 20 farmers using 'Simple Random Sampling with Replacement'. Most of the data are represented through suitable diagrams for better understanding and comparison.

V. RESULT AND DISCUSSION

Section-A: Analysis of Soil Properties and Nutrients

1: Physical Properties

Physical properties mean those properties which can be understood without making any chemical analysis of soil. It can be understood by seen the soil particles in microscope or testing soil samples by hand using feel method. Here some major physical properties like texture, structure, porosity and permeability have been analyzed.

1.1: Texture-

Laboratory experiments show that all of the 10 soil samples are characterized by dominance of clay materials. The amount of clay will be more than 60% in 7 soil samples and other 3 it will be between 50%-60%. Silt is the second dominant soil particles in all of the soil samples and sand can be seen very little in soil samples. Thus the region is characterized by Silty-clay type of soil throughout the agricultural land.

1.2: Structure-

As the soil is not very newly formed soil therefore it should has a well defined structure. The region is well developed in agriculture and thus the soil must be fertile. A structure less soil cannot be fertile to produce high amount of crops.

1.3: Porosity-

Porosity refers to amount of void space within the soil. The most controlling factor of soil porosity is texture of the soil. The amount of void space in the soil of the study area is very less due to abundance of clay material.

1.4: Permeability, infiltration rate and water holding capacity-

The soil of the study area characterized by less permeability .thus the infiltration rate will be very slow. The soil can be hold water for a long time. Thus we seen the region is dominated by paddy cultivation.

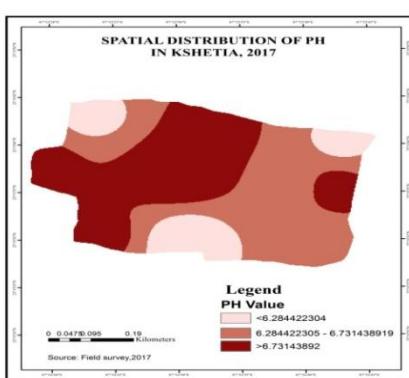
2: Chemical Properties

Chemical properties refer to the variables that control the chemical composition of soil. It can be determined by various chemical analyses of soil samples in the laboratory. The major chemical properties of soil of the study area are identified through laboratory experiment and statistical analysis of collected soil samples and there outcomes have been described in the following table-

Sample no.	Ph value	Organic Carbon		Nitrogen		Phosphate		Potassium	
		Range	Mid value	Range	Mid value	Range	Mid value	Range	Mid value
1	6.5	0.5-0.7	0.6	1.8-2.7	2.25	20-60	40	150-200	175
2	7	0.3-0.5	0.4	0.9-1.8	1.35	0-20	10	50-100	75
3	7	0.3-0.5	0.4	1.8-2.7	2.25	20-60	40	50-100	75
4	6	0.7-0.9	0.6	1.8-2.7	2.25	20-60	40	200-250	225
5	5.5	0.3-0.5	0.4	0.9-1.8	1.35	20-60	40	100-150	125
6	7	0.3-0.5	0.4	1.8-2.7	2.25	0-20	10	50-100	75
7	7.5	0.3-0.5	0.4	0.9-1.8	1.35	20-60	40	50-100	75
8	7	0.3-0.5	0.4	0.0-0.9	0.45	60-80	70	50-100	75
9	6.5	0.3-0.5	0.4	1.8-2.7	2.25	20-60	40	50-100	75
10	6	0.5-0.7	0.6	1.8-2.7	2.25	60-80	70	50-100	75
Mean Value	6.6	0.46		1.8		40		105	
SD	0.583095	0.091651514		0.603738354		18.97366596		50.99019514	
Coeff. of variance	0.088348	0.199242422		0.335410197		0.474341649		0.485620906	

Source: Laboratory test of collected soil samples

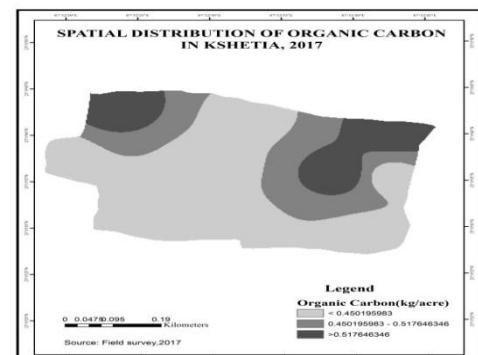
2.1: Soil pH



Soil pH refers to the measure which indicates the acidic or alkaline nature of soil. The pH value ranges between 0-14 where pH 7 indicates neutral, below 7 acidic and above 7 alkaline nature of soil respectively. The pH value of the soil samples indicates that most of the area is characterized by neutral to very slightly acidic soil. Little portion has slightly acidic to medium acidic soil and only a very small portion is marked by very slightly alkaline soil. The coefficient of variance indicates that there is insignificant variability in the soil pH value within the village. The little variation in pH is due to the variability in the irrigation techniques. Land which is irrigated by tube well or well is characterized by very slightly alkaline soil and unirrigated lands slightly acidic soil. Lands having irrigation through canal have presence of neutral to very slightly acidic soil.

2.2: Organic matter or Organic carbon

The amount of soil organic matter or organic carbon contributes only 2-10% of entire soil mass but it has too much influence in physical and chemical properties and bio function of soil. The amount of soil organic matter is low in most of the area of Kshetia village though few areas have medium concentration of organic matter within soil. The little variability in soil organic matter within the village is due to differential techniques used in crop harvesting. In machinery harvesting process some portion of crops is left in the land as residual which cause slight increase in organic matter of soil.



2.3: Soil nutrients

Soil nutrients refer to some minerals which are the significant controllers of the soil fertility and productivity. In other words the minerals which act as food of the vegetation or crops that grow on the soil are called soil nutrients. Among various soil nutrients Nitrogen, Phosphorus and Potassium or NPK have significant impact in soil fertility and productivity.

2.3.1: Nitrogen-

Nitrogen is the source of protein not only in plants but also in animal body. There are only few bacteria and plants that absorb nitrogen from air and help to concentrate it within soil. Soil in most of the area within the village has medium amount of nitrogen concentration with medium variability. As the village only cultivate rice than the variability is caused by differential use of urea and ammonia fertilizer.

2.3.2: Phosphate

Availability of phosphate within soil highly influences plant growth as it is a macronutrient that controls photosynthesis. Distribution of phosphate within soil is quite variable in this village merely because of variability in fertilizer use. Maximum portion have medium to high amount of phosphates within soil though a slight portion has very little amount of phosphorous.

2.3.3: Potassium

Potassium highly influences the enzyme formation, CO₂ uptake and ATP formation of plants. Soil pH is a significant controller of potassium concentration. But the village is characterized by very slight variability in soil pH but much variability in potassium. This means here the agricultural techniques most notably use of fertilizer is the actual controller of potassium concentration rather than the soil pH. Amount of potassium is generally low in the region though there is some extreme case where the potassium is highly concentrated.

Like other agricultural region Kshetia village also represents the human interference on the natural system through the variability in soil, a natural unit within the same and very small natural region. Agriculture here becomes the most significant controller of the soil properties in small spatial scale though in large scale it may reflects different results.

Section-B: Analysis of Agricultural Pattern

1: Cropping Pattern

All the agricultural land of the study area is characterized by only rice cultivation. Most of the land produces two types of rice in two different seasons-

1. *Ause* during March to June
2. *Aman* during July to October

In the sowing season of both the rice the land requires huge amount of water. As *Ause* sown during March therefore the irrigation facility should be better than *Aman* cultivation which is sown during monsoon. Thus the expenditure for irrigation is more for *Ause*. The farmers also cultivated *Boro* rice in winter season about 10 years ago but now they do not find that profitable. The production of rice in the village is near about 1.3 quintal in per hectare agricultural land. The productivity of *Aman* is too much higher than the production of *Ause*. The percentage of production of *Ause* and *Aman* are 10 and 90 between total productions respectively.

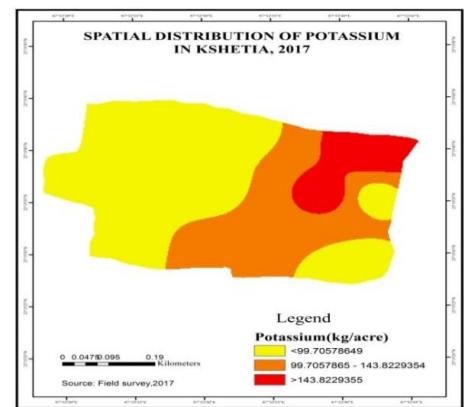
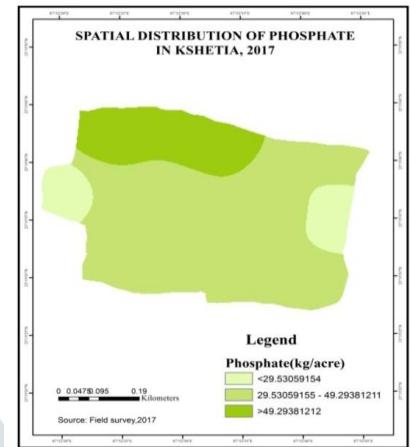
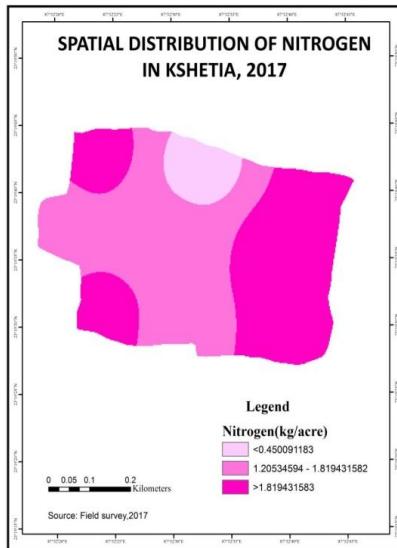
Going two or three years back the village is also known for producing vegetables in high quantity after rice. But now a days its become insignificant and limited to only little of the land for commercial purpose and some of the houses for domestic purpose. The land produce vegetables between November to February most clearly after the harvesting of *Aman* rice and Before sowing *Ause* rice.

2: Agricultural Techniques

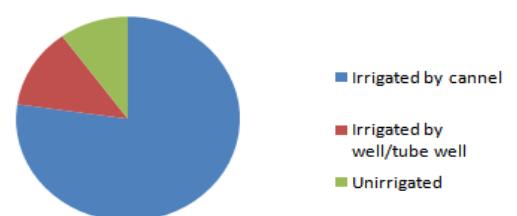
The region is characterized by use of modern agricultural techniques. The farmers have knowledge to use modern agricultural techniques in different phase of production.

2.1: Irrigation

The agricultural land of the village has well irrigation facility. About 90% of total agricultural land comes under irrigation. Within this 90% land about 77% is done through ground canal and remaining 13% done through electric pump set. The ground canals are drawn from several water bodies present within the village which act as water reservoir. Use of groundwater as a source of irrigation is significantly lower because the region has significant monsoon and pre monsoon rainfall. Though if there is delay in monsoon rainfall then the irrigation done through use of diesel pump set and water drawn from the water bodies as the amount of water level is lower than the height ground canal.



Condition of Irrigation During Census 2011



Source: Primary Census Abstract, 2011

There is no change in the amount of irrigated and un-irrigated land in last 17 years. This means that the village has suitable irrigation techniques from very earlier time. Farmers not faced any difficulties in the matter of irrigation techniques. But in the increasing cost in electricity and diesel now a day's becomes a reason of decreasing profit from agricultural sector.

2.2: Fertilizer and Pesticide

Use of chemical fertilizer and pesticide is an important characteristic of the agricultural techniques of the village. In this region mainly 3 types of chemical fertilizer has been used-Urea, Ammonia and Potash. Usually these fertilizers are used 3 times in a year for those lands in which both *Ause* and *Aman* cultivation are made. The annual use of different chemical fertilizers in per hectare agricultural lands is 130-150kg, 70-75kg and 70-80kg for Urea, Ammonia and Potash respectively. This region needs to use little amount of Zinc Sulfate as amount of sulfur is much available within soil. The annual use of fertilizer is about double than the state average which is about 145kg/hectare because of most of the land produce rice two times in a year.

Table: Use of Different Fertilizer

Type of the Fertilizer	Amount (kg/hectare)
Nitrogen	100-150
Potash	40-50
Phosphate	50-60
Zinc	Up to 25

Source: Primary Survey

The use of pesticides is also notable in this village. Like other area of West Bengal the farmers of this village had started using pesticide through DDT but now they have moved to folidol, endrin etc. Still the region is far away from using bio fertilizer and bio pesticide.

2.3: Agricultural Equipments

Use of modern agricultural equipments is seen in the village during sowing, growing and harvesting of crops. The plugging of land before sowing of crops is entirely done by using tractor. During growing period electric and diesel pump sets are used for irrigation and the crops are harvested using harvesting machine. Yet in some agricultural lands harvesting of crops has been done by traditional method which requires more human power. In addition, for spraying pesticides in agricultural land sprayer machine is used.

3: Marketing of Crops

For any agricultural process marketing of produced crops is a very important matter. There requires several processes and infrastructures for selling the crops.

3.1: Storage of Crops

The produced crops are stored within the village in farmers own house. Farmers build a place for storage of paddy before selling it to market within their own house. There are no such infrastructure required for storage of paddy thus they store in their own house.

3.2: Transportation and Selling

Farmers kept some amount of crops for their domestic use and remaining amount has been sold into market. Burdwan town and nearby Bhatar are the market area for selling the crops. The transportation of crops usually done by track via SH-14. Little amount of crops is transported via railway.

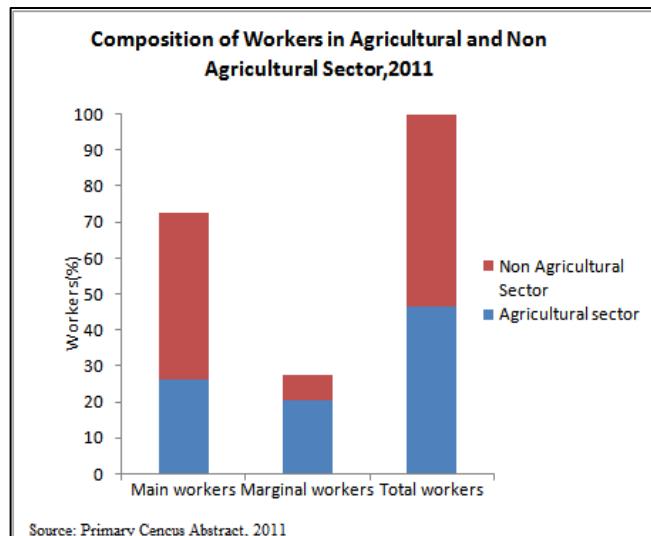
Section-C: Agriculture and Village Economy

Agriculture has too much influence in village economy and it is the major source of income for maximum workers. Village has an important position in terms of agriculture within the block.

1: Workforce Participation

In this village we find both main and marginal workers in every economic sector as well as agriculture. Main workers are those who involve in the particular economic activity throughout the year. Usually main workers are only belonging to only one particular sector, say agriculture or household workers.

1.1: Workers Involvement in Agricultural and Non-Agricultural Activity



As per census 2011 report among the total workers 46.49% belong to agricultural sector. There are 3 major economic activities in this village-agriculture, industrial work and household work. The proportion of main workers of total workers is 72.45% in which agricultural sector contributes only 26.20% which is significantly lower compared to non-agricultural activities. In marginal working sector the scenario is just the opposite. Within 27.55% of marginal workers 20.29% belong to agriculture and rest 7.26% involve in non agricultural activities.

The reason behind this particular working pattern has been understand by personal interview of villagers. The workers belong to agriculture generally involved maximum 8 to 9 month and a minimum 4 month period. In the remaining time period they usually goes other states most notably Rajasthan and Kerala to work in the construction sector. Though some workers in nearby town and villages. Only very small numbers are continuing cultivation and they cultivate different types of vegetables in the winter season.

1.2: Working Pattern in Agricultural Sector

Within total workers in agricultural sector 51.85% are cultivators and remaining 48.15% act as agricultural labor. The agricultural labors get a certain portion of crops by cultivating in others land. Most of the cultivators generally work throughout the year and thus 39.15% are main workers and remaining 12.70% belong to marginal worker. It is very difficult get work throughout the year for agricultural labors and there for most of them belong to marginal worker.

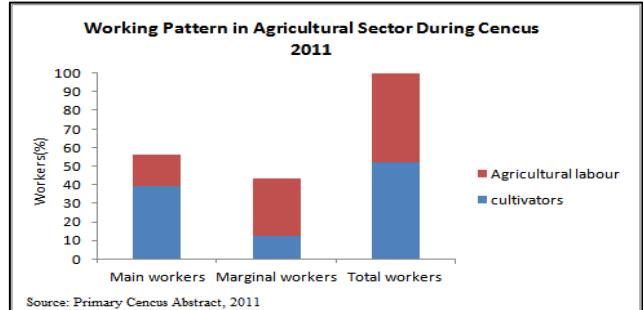


Table: Distribution of Workers at Burdwan-I (2011)

Percentage of workers	Agricultural sector	Non Agricultural Sector
Main workers	38.56	32.23
Marginal workers	21.21	8
Total workers	59.77	40.23

Source: Primary Census Abstract, 2011

2: Position of the Village in Agricultural Sector within the Block

Kshetia village is located within Bardhaman-I block which is very much developed in terms of agriculture. In spite of this Kshetia has very good position compared to other village of the same block.

The amount of production in per hectare land is little bit higher than the average per hectare production in the block though the workforce employment is also very different. The workforce employment in agricultural sector is lower than the employment in block. About 59.77% of total workers involved in agriculture which is about 13% higher than this village. Also the contribution of agriculture as main worker is significantly lower in this village. This is due to cultivation of paddy only which makes them workless for a period of 4 months while the other villages of the blocks grow vegetables for the remaining time period. Also it resembles that he cultivation of paddy is more profitable to the farmers and they are very efficient in cultivating paddy than the vegetables.

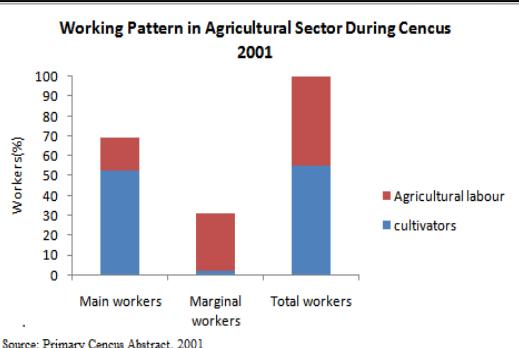
3: Temporal Variation and Recent Trend

With the passage of time the technology and working pattern has significantly changed in almost everywhere and agriculture is one of them. Agricultural landuse and workforce has significantly changed in recent time.

3.1: Landuse Pattern

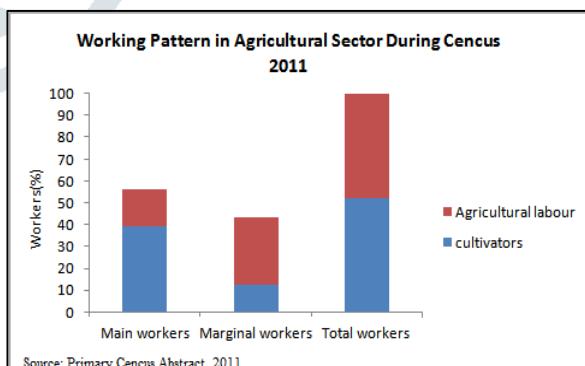
There is no change in the total amount of agricultural land for a long time. But the use of land for different types of rice has significantly changed. In few years ago some portion of the land is used for *Boro* rice but now that is not seen in the village. Also the vegetable cultivation is replaced by *Aman* rice now days. Similarly no change in the total amount of irrigated land but amount of water required for irrigation has significantly increased.

3.2: Workforce Structure



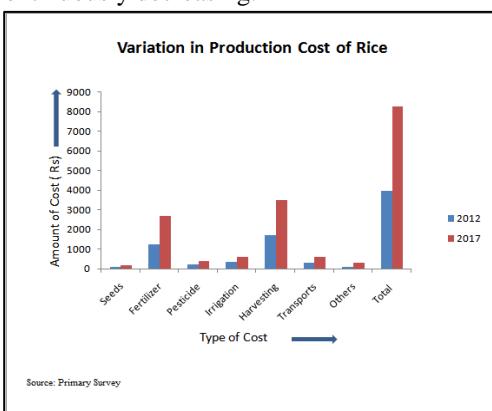
Participation of workers in agricultural sector has significantly changed in recent past. There is about 10% decrease in contribution of agricultural sector in total workers within Cencus 2001 and Cencus 2011. The growth of several industries in nearby town is an important reason for this change. Also the main workers from agricultural sector have been decreased by about 12.5% between Cencus dominance of paddy cultivation has increased enormously between both the Cencus. Again people have become more aware about job opportunity outside their residential area so they now involved other work along with agriculture.

In recent time the people becomes more interested in industrial work. Some worker now works in under construction industry near Norja which is just 10km away from the village. Thus the participation of workers in agricultural sector is continuously decreasing.



3.3: Agricultural Production

In last 5 years there are significant changes in agricultural production in terms of total amount of produced crops, production cost and net profit gain from the cultivation. The cost in every steps during agricultural like seeding, fertilizer cost, harvesting cost have become almost double compared to 2012 which makes about 108% increase in agricultural production cost in total. Surprisingly, the selling price of paddy has increased slightly, just about 27% in last 5 years. Increase in per hectare production gives little relief to the farmers which minimize the impact of huge increase in production cost. The scientific technologies, use of modern equipments, increase in awareness of farmers have collectively brought increase in production. The production increases by about 45% whereas profit from per hectare agricultural land has increased by almost 42%.



Section-D: Major Problems and Suggestions**1: Major Problems**

Through detail analysis in previous chapters it is cleared that the study area is much developed in agriculture, especially in rice cultivation. But in recent few years it has some new problems and some old problems which are more intensifying.

- i. Intensifying tropical cyclone.
- ii. Increase in production cost.
- iii. Decrease in land fertility
- iv. Absence of proper rail transport
- v. Delay in payment of agricultural insurance.
- vi. Absence of compensation for agricultural labour.

2: Suggestions

Till today there is no control of human beings on natural phenomena. Thus there is only way to control climatic hazard by proper alarming system. Land fertility can be increased by use of proper agricultural techniques. Proper initiatives from state and central government can solve other aforementioned problems.

VI. CONCLUSION

Like maximum Indian villages agriculture is the dominant economic activity and for most of the villagers it is the only source of income. Fertile soil, suitable climatic condition and moderately good socio economic conditions collectively help for development of agriculture. Though it is now facing some problems today but hope those are solved very soon and the villagers may concentrate more in agriculture in future.

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