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Critical Analysis of Sustainable Agricultural Development in Cooch Behar District, West Bengal

Debolina Pandit[1], Dr. Hukam Singh Choudhary[2]
[1,2] *Department of Geography, Mansarovar Global University, Sehore, MP*

ABSTRACT:
Agriculture is the principal livelihood of the rural population in Cooch Behar district, West Bengal, and plays a significant role in the regional economy. However, the sustainability of agricultural development in the district is influenced by a complex interaction of environmental, economic, social and institutional factors. The district possesses considerable cultivable land and abundant surface and groundwater resources for sustainable agricultural development. The study assesses the extent to which existing agricultural practices conform to the principles of sustainable development. This paper reflects a critical analysis of Sustainable Agricultural Development in Cooch Behar district of West Bengal.
KEYWORDS: *Rural population, Economic, Cooch Behar District, Sustainable, livelihoods.*

I. INTRODUCTION:

Agriculture in India is a vital economic sector that employs over 40% of the workforce and contributes roughly 17–18% to the national GDP. India ranks second globally in farm output, leading the world in the production of milk, pulses, and spices, and serving as a major producer of rice, wheat, and cotton.

Agriculture is the backbone of India's rural economy and plays a vital role in ensuring food security, generating employment, and promoting socio-economic development. In West Bengal, agriculture contributes significantly to the livelihoods of the rural population. Among the agriculturally important districts of North Bengal, Cooch Behar District occupies a special position because of its fertile alluvial soil, favourable climatic conditions, and abundant water resources. The district is predominantly agrarian, with a large proportion of the population directly or indirectly dependent on agriculture and allied activities such as livestock rearing, fisheries, sericulture, and horticulture for their livelihoods.

Sustainable agricultural development has emerged as an important concept in recent decades due to increasing environmental degradation, declining soil fertility, climate change, and the pressure of population growth on natural resources. Sustainable agriculture aims to increase agricultural productivity while conserving land, water, biodiversity, and ecological balance for future generations. It emphasises environmentally sound farming practices, economic profitability, and social equity. In a region like Cooch Behar, where agriculture is highly dependent on monsoon rainfall and river systems, sustainability becomes essential for maintaining long-term agricultural productivity and rural stability.

Status of Agriculture in Cooch Behar District:

Agriculture in Cooch Behar is characterised mainly by small and marginal landholdings, intensive cultivation, and reliance on traditional farming practices. Paddy is the dominant crop and forms the basis of the district's farming system. Crop combinations such as Paddy–Jute–Paddy and Potato–Vegetables–Paddy are common in many blocks. Integrated farming systems, such as paddy-cum-fish culture and livestock farming, are also practised in several areas. Despite favourable natural conditions, the district faces numerous agricultural challenges, including riverbank erosion, floods, waterlogging, declining soil fertility, inadequate irrigation facilities, landholding fragmentation, and climate variability.

The increasing use of chemical fertilisers and pesticides has adversely affected soil health and ecological balance in many parts of the district. Studies indicate that soil fertility degradation, nutrient depletion, and reduction in soil organic matter have become major concerns affecting agricultural sustainability in Cooch Behar. Furthermore, unpredictable rainfall patterns and climate change have created uncertainty in crop production. Variability in monsoon rainfall often affects sowing, irrigation, and harvesting practices, thereby reducing agricultural productivity and increasing farmers' vulnerability.

To address these challenges, sustainable agricultural development has become essential in the district. Various government initiatives and institutional efforts are being undertaken to promote sustainable farming practices. Agricultural extension services, crop diversification, organic farming, soil conservation, integrated pest management, irrigation development, and climate-resilient agriculture are increasingly emphasised. The district

administration and agricultural departments are also promoting modernised marketing systems, farmer training programs, storage facilities, and participation in self-help groups to strengthen the rural agricultural economy.

II. OBJECTIVES OF THE STUDY:

- To evaluate the geographical exposure for sustainable agricultural practices.
- To analyse the cost-effective strategy for sustainable agricultural development within the district.

III. RESEARCH METHODOLOGY:

The research methodology includes a description of the research design, outlining the study's overall approach and structure.

In simple terms, research methodology outlines what the researcher is doing in their study. To plan effectively, research methodology provides the right platform to map out the research in a relevant way and make plans. Research varies depending on the objectives, and this can be addressed by adopting an appropriate methodology.

Research Design:

A research design is the overall plan or blueprint for conducting a study. It explains how data will be collected, measured, and analysed to answer a research question or test a hypothesis.

Here, the Research Design includes both Quantitative and Qualitative methods.

Study Area: Cooch Behar District

Data Collection:

Primary Data:

Information first obtained from first-hand recollections or other sources is referred to as primary data for research purposes. Sometimes, people refer to it as raw data or first-hand knowledge. The investigator provides direct supervision and management of the data collection process.

Here, Primary data were collected through an "Interview Schedule" from farmers and rural people in the Cooch Behar district.

Sample Size: 600 (Farmers: 150 & Rural People:450)

IV. DATA ANALYSIS AND FINDINGS:

PART A: QUANTITATIVE ANALYSIS OF RESPONSES OF FARMERS

1. GENDER:

Table 1. Gender of the Respondents

Gender	Numbers of Respondents	Percentages of Respondents (%)
Male	125	83
Female	25	17
Total	150	100

Source: Primary Data, Survey

From the table and graph above, male respondents accounted for 83%, while female respondents accounted for 17%.

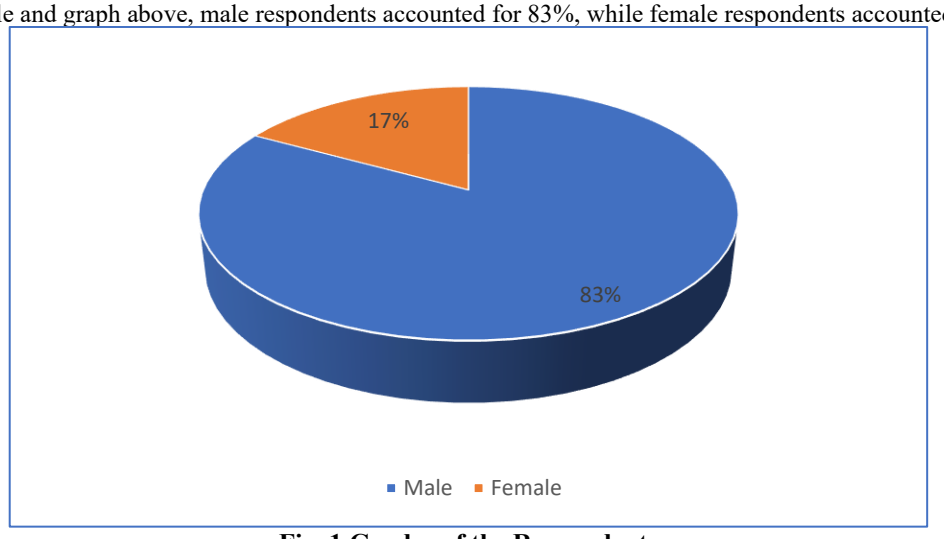

Fig. 1 Gender of the Respondents

2. BLOCK-WISE DISTRIBUTION:

Table 2: Block-wise distribution of Respondents:

Block Name	Numbers of Respondents	Percentages of Respondents (%)
Cooch Behar-I & Cooch Behar-II	30	20
Mathabhanga-I & Mathabhanga-II	30	20
Tufanganj-I & Tufanganj-II	30	20
Mekhliganj & Haldibari	30	20
Sitalkuchi & Sitai	30	20
Total	150	100

Source: Primary Data, Survey

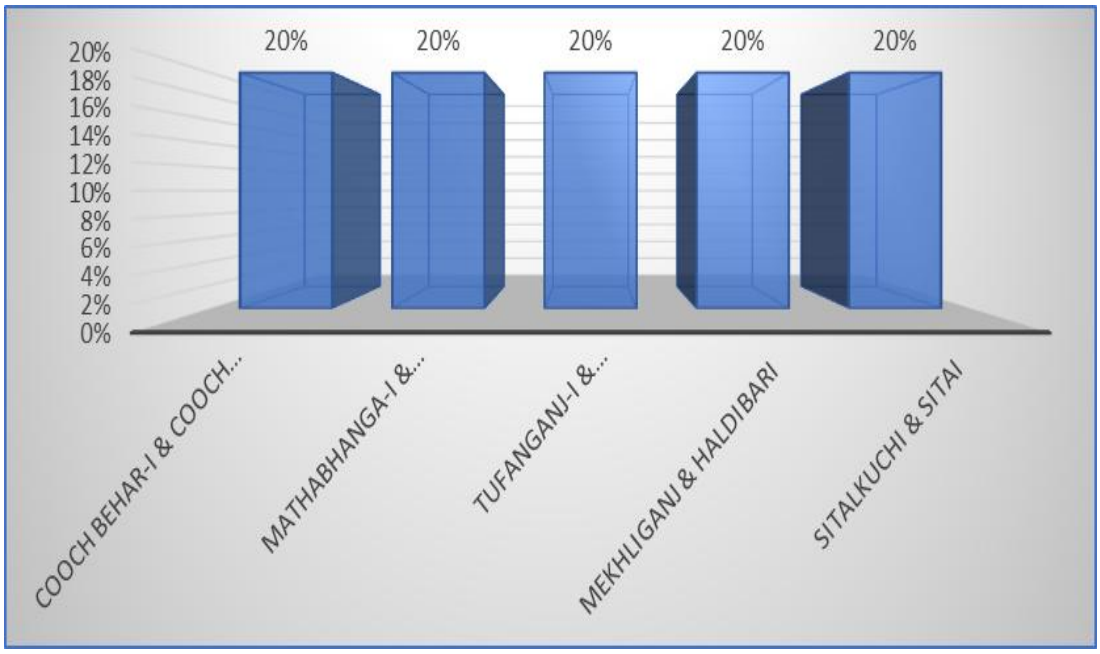

Fig.2 : Block-wise distribution of Respondents

From the above data, it is evident that 30 respondents have been selected from each of the following blocks: Cooch Behar-I & Cooch Behar-II, Mathabhanga-I & Mathabhanga-II, Tufanganj-I & Tufanganj-II, Mekhliganj & Haldibari, and Sitalkuchi & Sitai.

3.AVAILABILITY OF NATURAL RESOURCES FOR SUSTAINABLE AGRICULTURE

Table 3: Availability of Natural Resources for Sustainable Agriculture

Availability of Natural Resources for Sustainable Agriculture	Numbers of Respondents	Percentages of Respondents (%)
Yes	120	80
No	30	20
Total	150	100

Source: Primary Data, Survey

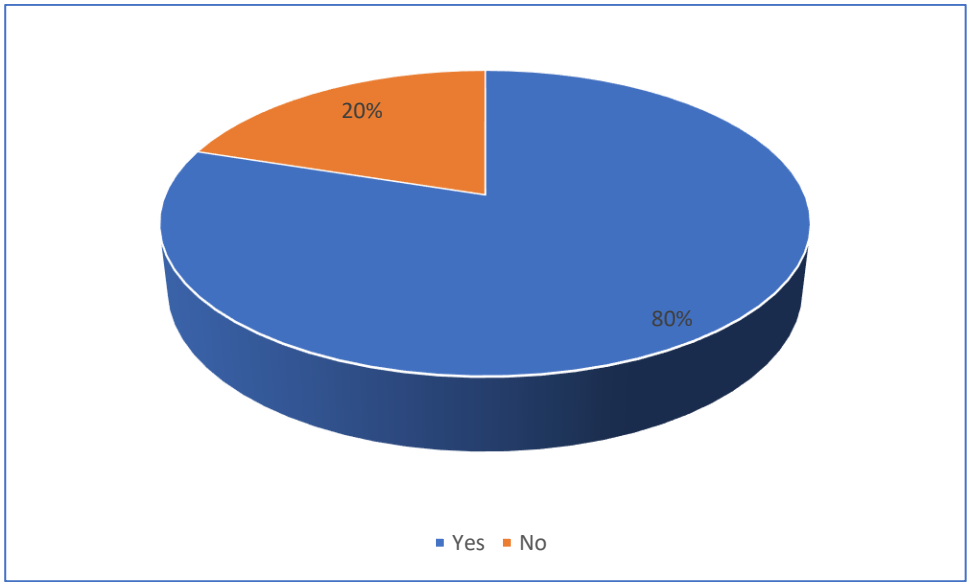

Fig. 3 : Availability of Natural Resources for Sustainable Agriculture

From the above data, it is evident that 80% of the total respondents have given a favourable answer, whereas 20% have not given.

4.AVAILABILITY OF HUMAN RESOURCES FOR SUSTAINABLE AGRICULTURE

Table 4 : Availability of Human Resources for Sustainable Agriculture

Availability of Human Resources for Sustainable Agriculture	Numbers of Respondents	Percentages of Respondents (%)
Yes	120	80
No	30	20
Total	150	100

Source: Primary Data, Survey

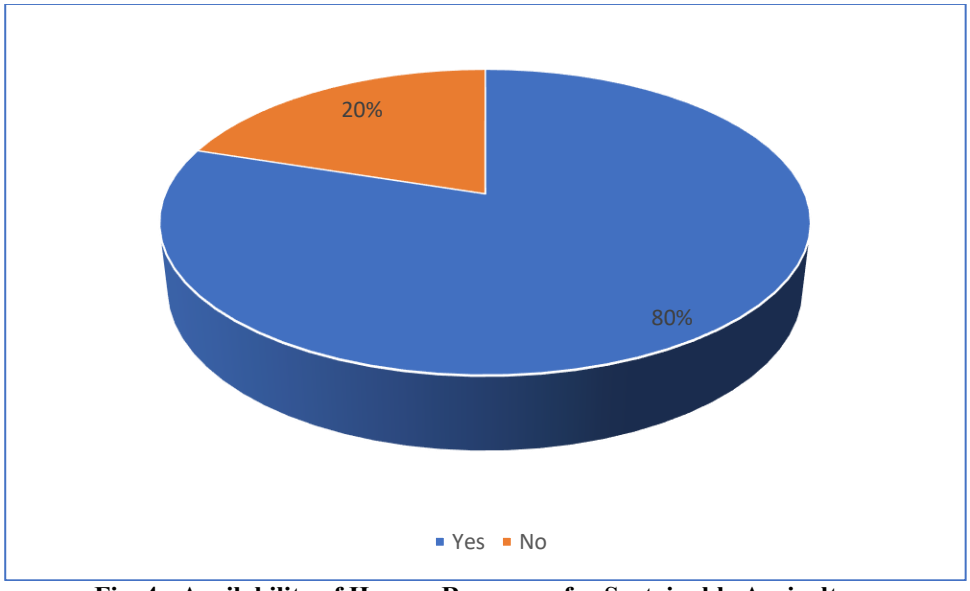

Fig. 4 : Availability of Human Resources for Sustainable Agriculture

From the above data, it is evident that 80% of the total respondents have given a favourable answer, whereas 20% have not given.

5. AVAILABILITY OF WATER FOR AGRICULTURE IN SELECTED AREAS

Table 5: Availability of Water for Agriculture in Selected Areas

Options	Numbers of Respondents	Percentages of Respondents (%)
Very poor	0	0
Poor	0	0
Moderate	20	13
Good	70	47
Very Good	60	40
Total	150	100

Source: Primary Data, Survey

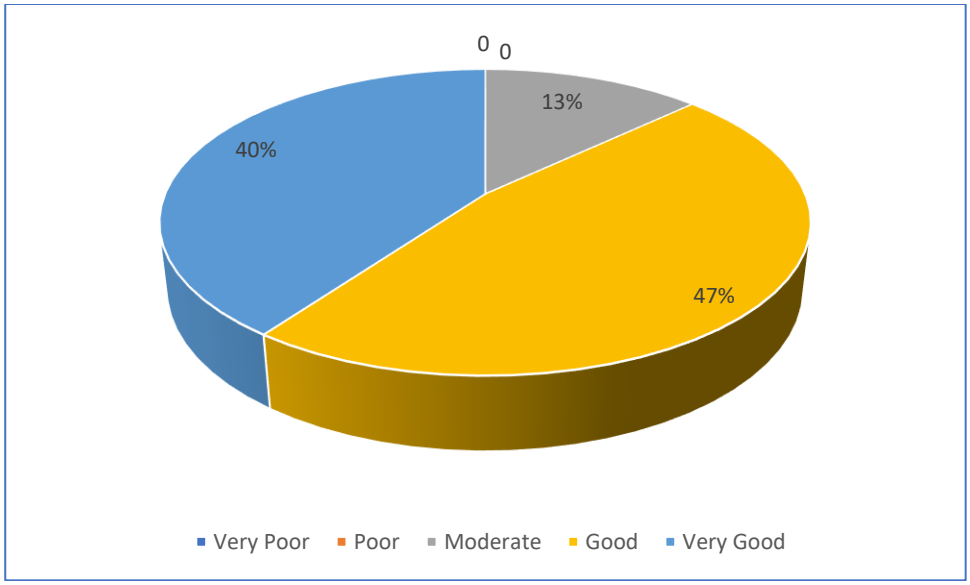

Fig. 5 Availability of Water for Agriculture in Selected Areas

According to the data, 13% of respondents reported that the availability of water for agriculture in the area is moderate, whereas 47% said it is good and 40% said it is very good.

6. CLIMATIC CHANGES AFFECT SUSTAINABLE AGRICULTURAL ACTIVITIES

Table 6: Climatic Changes Affect Sustainable Agricultural Activities

Options	Numbers of Respondents	Percentages of Respondents (%)
Not at all	0	0
Slightly	10	7
Moderately	30	20
Significantly	40	27
Very significantly	70	46
Total	150	100

Source: Primary Data, Survey

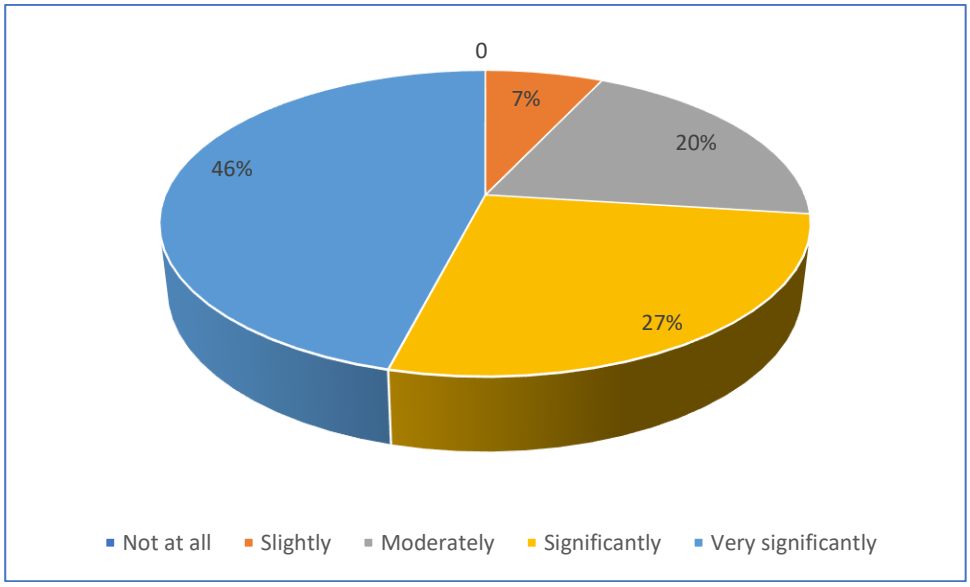

Fig.6 : Climatic Changes Affect Sustainable Agricultural Activities

According to the data, 7% of respondents said that Climatic Changes Affect Sustainable Agricultural Activities Slightly, 20% said Moderately, 27% said Significantly, and 46% said Very Significantly.

7. GEOGRAPHICAL LOCATION AFFECTS ABILITY TO ADOPT SUSTAINABLE FARMING PRACTICES

Table 7: Geographical Location Affects Ability to Adopt Sustainable Farming Practices

Options	Numbers of Respondents	Percentages of Respondents (%)
Not at all	0	0
Slightly	0	0
Moderately	30	20
Significantly	80	53
Very significantly	40	27
Total	150	100

Source: Primary Data, Survey

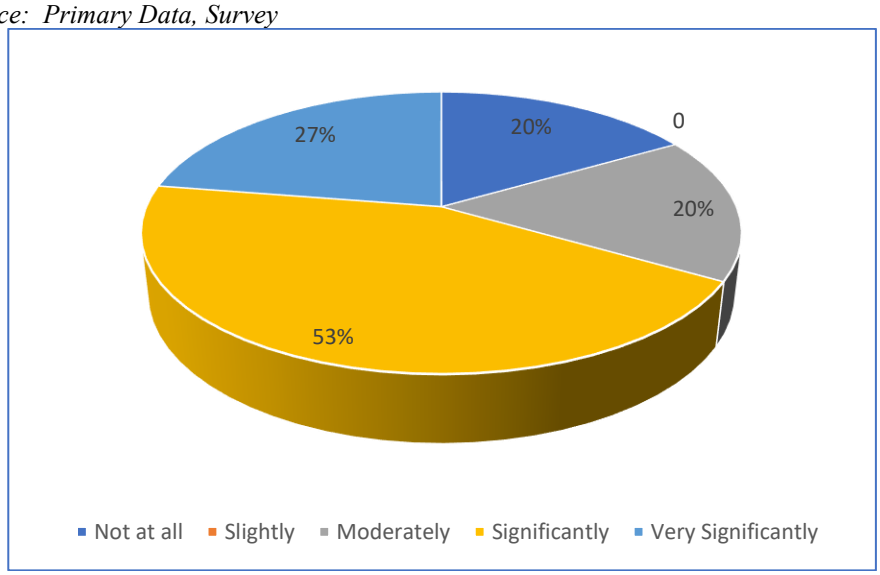

Fig.7 : Geographical Location Affects Ability to Adopt Sustainable Farming Practices

According to the data, 20% said "moderate" regarding "Geographical Location Affects Ability to Adopt Sustainable Farming Practices", 53% said "significantly", and 27% said "very significantly".

8. GEOGRAPHICAL FACTORS OF SELECTED STUDY AREAS MOST INFLUENCING ADOPTION OF SUSTAINABLE AGRICULTURE

Table 8: Geographical Factors of Selected Study Areas Most Influencing Adoption of Sustainable Agriculture

Options	Numbers of Respondents	Percentages of Respondents (%)
Soil Characteristics	50	33
Water Availability	100	67
Flooding/Waterlogging	60	40
Distance From Markets	10	7
Road Connectivity	0	0
Availability of Agricultural Inputs	70	47
Climate/Rainfall	90	60
Access To Extension Services	20	13
Landholding Characteristics	40	27
Other	30	20

Source: Primary Data, Survey

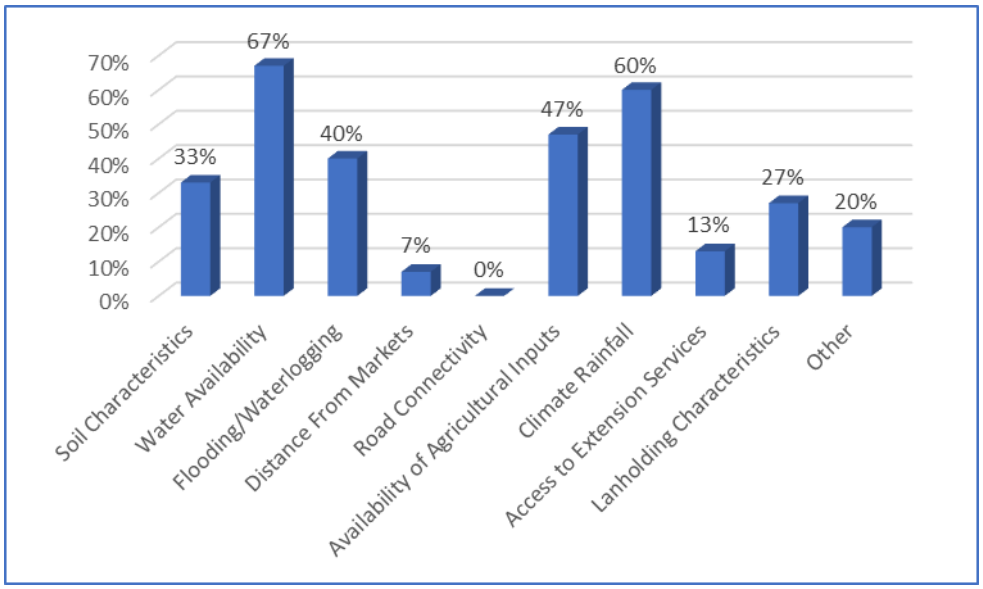

Fig. 8 : Geographical Factors of Study Areas Most Influencing Adoption of Sustainable Agriculture

According to the data, 20% of respondents said that geographical factors are the most influential factor in the adoption of sustainable agriculture, whereas 20% said moderate, 53% said significantly, and 27% said very significantly.

PART B: QUANTITATIVE ANALYSIS OF RESPONSES OF RURAL PEOPLE

9. Gender of the Respondents

Table 9 : Gender of the Respondents

Gender	Numbers of Respondents	Percentages of Respondents (%)
Male	350	78
Female	100	22
Total	450	100

Source: Primary Data, Survey

From the table and graph above, male respondents accounted for 78%, while female respondents accounted for 22%.

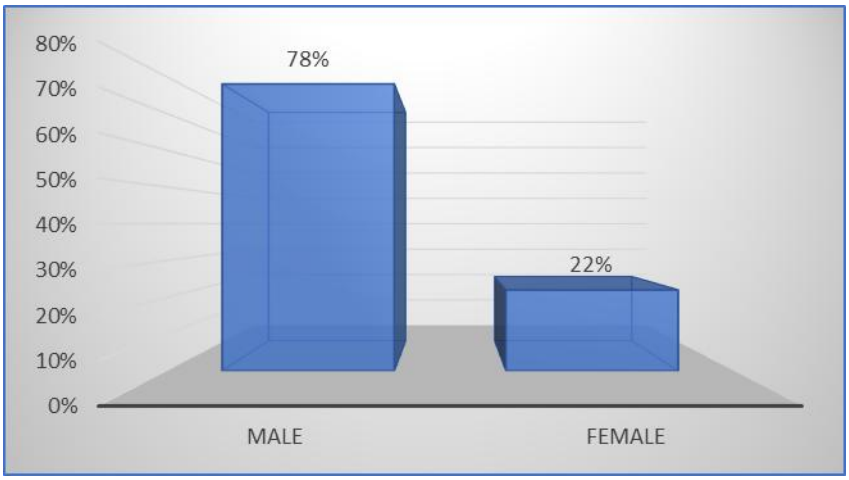

Fig.9 : Gender of the Respondents

10. Block-wise distribution of Respondents

Table 10 : Block-wise distribution of Respondents

Block Name	Numbers of Respondents	Percentages of Respondents (%)
Cooch Behar-I & Cooch Behar-II	90	20
Mathabhanga-I & Mathabhanga-II	90	20
Tufanganj-I & Tufanganj-II	90	20
Mekhliganj & Haldibari	90	20
Sitalkuchi & Sitai	90	20
Total	450	100

Source: Primary Data, Survey

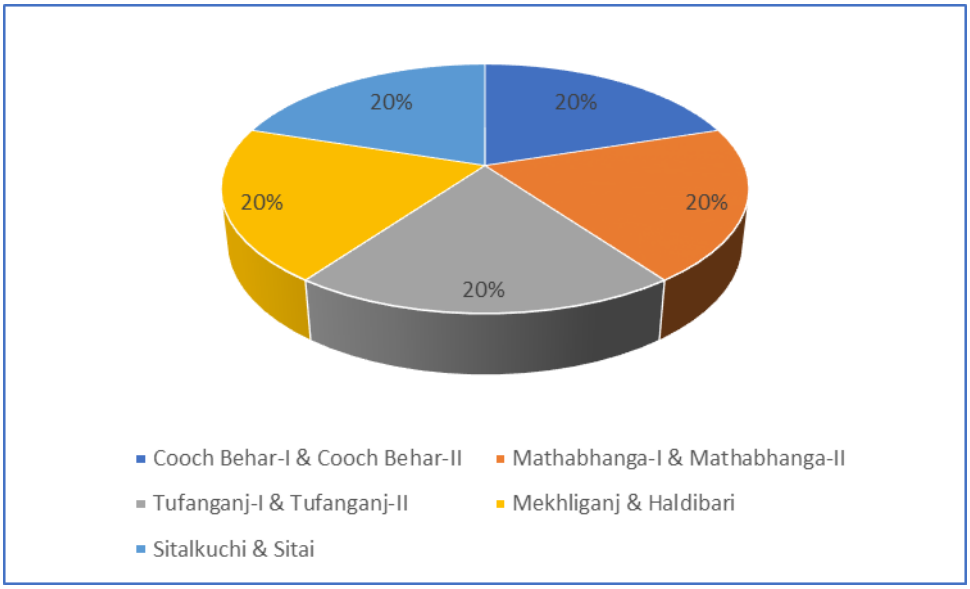

Fig. 10 : Block wise distribution of Respondents

From the above data, it is evident that 90 respondents have been selected from each block, namely, Cooch Behar-I & Cooch Behar-II, Mathabhanga-I & Mathabhanga-II, Tufanganj-I & Tufanganj-II, Mekhliganj & Haldibari and Sitalkuchi & Sitai.

11. AVAILABILITY OF WATER FOR AGRICULTURE IN AREAS

Table 11 : Availability of Water for Agriculture in Areas

Options	Numbers of Respondents	Percentages of Respondents (%)
Very poor	0	0
Poor	0	0
Moderate	90	20
Good	360	80
Very Good	0	0
Total	450	100

Source: Primary Data, Survey

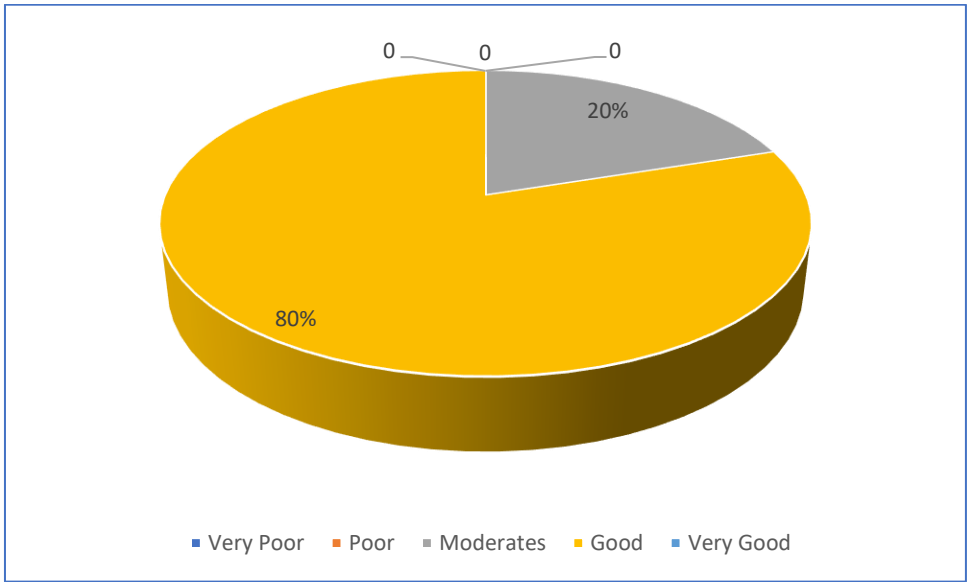

Fig. 11 : Availability of Water for Agriculture in Areas

According to the data, 20% of respondents reported that the availability of water for agriculture in the areas is moderate, whereas 80% said it is good.

12. FREQUENCY OF EXPERIENCING DROUGHT OR INADEQUATE RAINFALL IN THE AREA

Table 12: Frequency of Experiencing Drought or Inadequate Rainfall in the Areas

Options	Numbers of Respondents	Percentages of Respondents (%)
Never	360	80
Rarely	32	7
Sometimes	58	13
Frequently	0	0
Very frequently	0	0
Total	450	100

Source: Primary Data, Survey

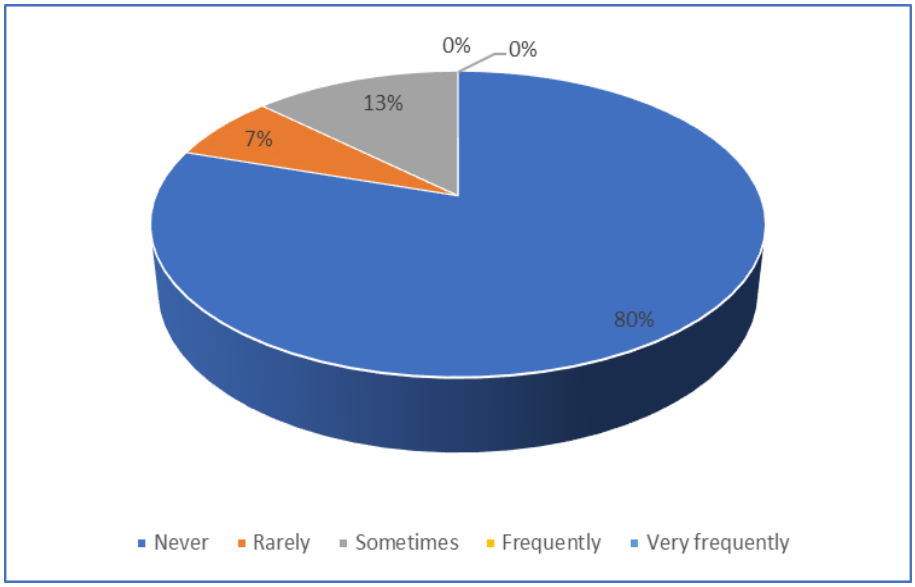

Fig. 12: Frequency of Experiencing Drought or Inadequate Rainfall in the Area

According to the data, 80% of respondents said they have not experienced drought, 7% said they rarely have experienced, and 13% said they sometimes have experienced.

13. CLIMATIC CHANGES IN THE AREAS AFFECTING SUSTAINABLE AGRICULTURAL ACTIVITIES

Table 13 : Climatic Changes Affecting Sustainable Agricultural Activities

Options	Numbers of Respondents	Percentage of Respondents (%)
Not at all	0	0
Slightly	32	7
Moderately	99	22
Significantly	112	25
Very Significantly	207	46
Total	450	100

Source: Primary Data, Survey

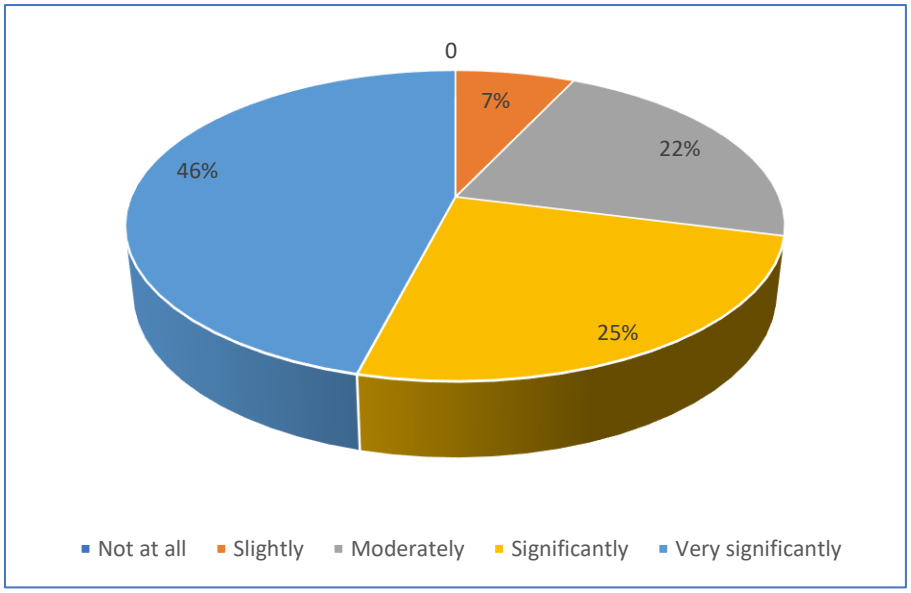

Fig. 13: Climatic Changes Affect Sustainable Agricultural Activities

According to the data, 7% of respondents said that Climatic Changes Affect Sustainable Agricultural Activities Slightly, 22% said Moderately, 25% said Significantly, and 46% said Very Significantly.

14. GEOGRAPHICAL LOCATION OF AREAS AFFECT ABILITY TO ADOPT SUSTAINABLE FARMING PRACTICES

Table 14 : Geographical Location Affects Ability to Adopt Sustainable Farming Practices

Options	Numbers of Respondents	Percentages of Respondents (%)
Not at all	0	0
Slightly	0	0
Moderately	113	25
Significantly	225	50
Very significantly	112	25
Total	450	100

Source: Primary Data, Survey

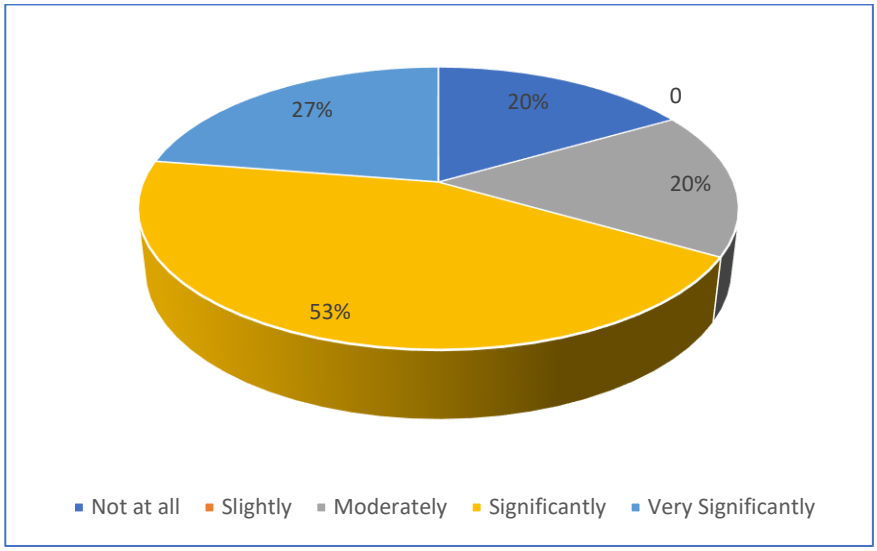

Fig. 14 : Geographical Location Affects Ability to Adopt Sustainable Farming Practices

According to the data, 25% of respondents said that geographical location moderately affects their ability to adopt sustainable farming practices, whereas 50% said it significantly affects, and the remaining 25% said it very significantly.

15. GEOGRAPHICAL FACTORS MOST INFLUENCING ADOPTION OF SUSTAINABLE AGRICULTURE

Table 15 : Geographical Factors most influencing Adoption of Sustainable Agriculture

Options	Numbers of Respondents	Percentages of Respondents (%)
Soil characteristics	158	35
Water Availability	293	65
Flooding/Waterlogging	202	45
Distance From Markets	45	10
Road Connectivity	0	0

Availability of Agricultural Inputs	225	50
Climate/Rainfall	248	55
Access To Extension Services	68	15
Landholding Characteristics	113	25
Other	68	15

Source: Primary Data, Survey

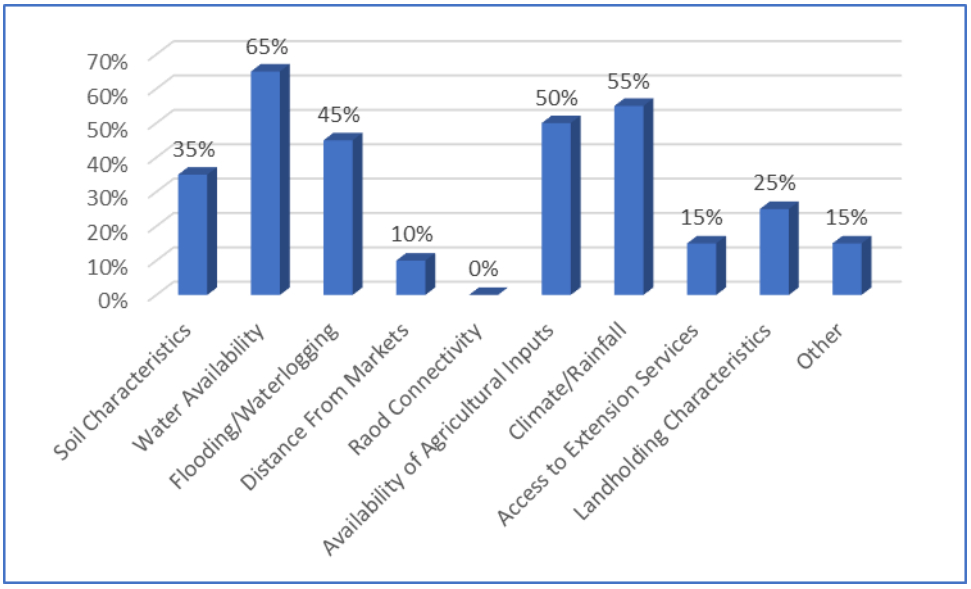

Fig. 15 : Geographical Factors most influencing Adoption of Sustainable Agriculture

According to the data, 35% of respondents said that Soil characteristics are the most influential factor in the adoption of sustainable agriculture, 65% said Water availability, 45% said Flooding/Waterlogging, 10% said distance from market, 50% said availability of agricultural Inputs, 55% said Climate/Rainfall,15% said Access to Extension Services, and 25% said landholding characteristics. Lastly, 15% said other reasons influencing Adoption of Sustainable Agriculture.

PART C: QUALITATIVE ANALYSIS BASED ON RESPONSES OF FARMERS & RURAL PEOPLE :

Cost-Effective Strategy for Sustainable Agriculture Development in Cooch Behar District:

A cost-effective strategy for sustainable agricultural development in Cooch Behar district should be designed around the district's specific conditions: high rainfall (over 3,000 mm annually), frequent flooding and river erosion, acidic alluvial soils, predominance of small and marginal farmers, and a rice–jute-based farming system.

1. **Promote Conservation Agriculture (Highest Priority) :**

Conservation Agriculture for Sustainable Intensification (CASI) has already shown promising results in Cooch Behar. Key practices include:

- Minimum tillage or zero tillage
- Crop residue retention
- Crop rotation and diversification
- Precision nutrient management

These practices reduce fuel, labour, and irrigation costs while improving soil health and productivity. Research from Cooch Behar found that adoption increases when farmers have access to machinery services and awareness programs.

Low-cost implementation:

- Establish village-level custom hiring centers for seed drills and small machinery.
- Train Farmer Producer Organizations (FPOs) and self-help groups.

2. **Diversify Beyond Rice and Jute :**

Overdependence on paddy and jute increases climate and market risks.

Recommended diversification:

- Mustard

- Lentil and black gram
- Maize
- Vegetables (cauliflower, cabbage, tomato, chilli)
- Mushroom cultivation
- Floriculture

The district's agro-climatic profile identifies diversification as a major thrust area for improving profitability.
Benefits:

- Higher income per hectare
- Better soil fertility through crop rotation
- Reduced vulnerability to rainfall fluctuations

3. **Integrated Farming Systems (IFS)**
A highly cost-effective approach for smallholders is integrating:

- Crops
- Fishery
- Poultry
- Dairy
- Duckery
- Vermicomposting

Examples already common in the district include:

- Paddy–fish systems
- Paddy–fish–poultry systems

Integrated farming improves nutrient recycling, reduces external input costs, and creates multiple income sources.

4. **Improve Water Management**
Although Cooch Behar receives abundant rainfall, agriculture suffers from both floods and dry spells. Rainfall variability increasingly affects crop yields.
Low-cost measures:

- Farm ponds
- Rainwater harvesting structures
- Solar-powered shallow tube wells
- Community irrigation systems
- Drainage channels in flood-prone areas

The district has substantial untapped groundwater potential and government-supported minor irrigation schemes.

5**. Soil Health Restoration**
Studies indicate declining soil fertility due to nutrient imbalance and reduced organic matter.
Cost-effective actions:

- Vermicompost production
- Green manuring (dhaincha)
- Crop residue incorporation
- Soil testing-based fertiliser use
- Lime application to reduce soil acidity

These measures reduce dependence on expensive chemical fertilisers while improving long-term productivity.

6. **Climate-Resilient Agriculture**
Given increasing rainfall irregularity and floods, farmers should adopt:

- Flood-tolerant rice varieties
- Short-duration crop varieties
- Raised-bed vegetable cultivation
- Crop insurance
- Agro-advisory services through mobile phones

Climate-smart agriculture initiatives in Cooch Behar have demonstrated the value of resilient technologies and practices.

7. **Strengthen Farmer Organizations and Value Addition**
Sustainable development depends not only on production but also on marketing.

Key interventions:
- Strengthen FPOs and cooperatives
- Jute grading and processing training
- Community storage structures
- Food processing and value addition
- Direct marketing through farmer markets

Existing district programs already support storage, processing, and marketing infrastructure.

8. **Promote Agroforestry and Riverbank Protection**

River erosion is a major cause of agricultural land loss in Cooch Behar.

Recommended measures:
- Bamboo plantation along riverbanks
- Fruit tree-based agroforestry
- Vetiver grass strips
- Community-managed erosion control

These measures provide both environmental protection and additional income.

V. CONCLUSION:

Cooch Behar District possesses significant agricultural potential due to its fertile alluvial soil, favourable climate, and abundance of water resources. Agriculture remains the backbone of the district's economy and supports the livelihood of a large section of the rural population. However, challenges such as fragmented landholdings, seasonal flooding, overreliance on traditional farming methods, excessive use of chemical fertilisers, declining soil fertility, and climate variability have hindered long-term agricultural sustainability.

Sustainable agricultural development in the district requires a balanced approach that integrates economic growth, environmental protection, and social well-being. Adoption of modern yet eco-friendly farming techniques such as organic farming, integrated nutrient management, crop diversification, efficient irrigation systems, and use of high-yield and climate-resilient crop varieties can enhance productivity while preserving natural resources. Promotion of agro-based industries, farmer cooperatives, storage facilities, and better market linkages can further improve farmers' income and rural employment opportunities.

Government initiatives, technological support, agricultural education, and farmer awareness are essential to achieving sustainable development goals in the agricultural sector. Active participation of local communities and proper utilisation of available resources can help ensure food security, ecological balance, and economic stability in the district.

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