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Assessment of Cropping Patterns, Agricultural Practices and Soil Fertility Management in Birendranagar Municipality

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Abstract: The study aimed to assess the cropping patterns, agricultural practices, and soil fertility management in Birendranagar municipality, Nepal in 2021. A mixed-methods approach was utilized, including structured questionnaires, interviews, and focus group discussions, to collect quantitative and qualitative data from a sample size of 135 participants selected through purposive sampling. The findings revealed variations in landholding status among different wards, with Ward 3 having the highest average upland area and Ward 4 having the highest average lowland area. Diverse cropping patterns were identified, including sequences such as Maize-Legume-Vegetable and Paddy-Wheat-Maize. Farmers in Birendranagar utilized both organic and inorganic fertilizers, with a preference for organic fertilizers observed in Ward 4. Farm Yard Manure was the primary source of organic manure, followed by poultry and goat/sheep manure. The study highlights the need for sustainable land and resource management to ensure long-term food security in the municipality. It provides valuable insights into current agricultural practices, which can guide the development of strategies to improve soil fertility, enhance agricultural productivity, and promote sustainable farming practices. The study also emphasizes the importance of diversifying cropping systems, reducing reliance on chemical inputs, and adopting sustainable land and water management practices. By understanding the prevailing cropping patterns and agricultural practices, the municipality can work towards a more resilient and sustainable agricultural system that supports food security and the well-being of the community.

Keywords: Cropping Patterns, Agricultural Practices, Soil Fertility Management

1. Introduction

Sustainable land and water resource management were considered critical for addressing the challenges of achieving food security and accommodating a growing global population [4]. In many developing countries, including Nepal, the increasing pressure from a growing population had led to land degradation and a decline in soil fertility [5, 2]. The productivity and sustainability of agricultural systems were heavily influenced by agricultural practices and cropping patterns. Gaining insights into current farming practices was essential to develop strategies for promoting sustainable land and resource management. Despite efforts to maintain soil fertility through recommended practices such as compost and manure application, the decline in soil fertility persisted, partly due to the limited adoption of improved techniques by farmers [3, 7]. Sustainable agriculture practices had garnered significant attention due to the country's heavy reliance on agriculture for livelihood and economic growth [6]. As a country with a majority of its population engaged in agriculture, adopting sustainable approaches was crucial for ensuring long-term food security and environmental conservation [1]. Proper soil fertility management practices played a significant role in enhancing crop productivity and maintaining ecological balance [2, 8]. Given Nepal's diverse agro-climatic conditions, it was vital to

adopt region-specific soil management techniques [3]. The Food and Agriculture Organization of the United Nations (FAO) emphasized the implementation of sustainable land and water management practices to improve food security and reduce soil degradation [4]. Additionally, Lal, R. [5] stressed the restoration of soil quality as a means to mitigate soil degradation and preserve arable land for future generations. In Nepal, the diversification of cropping patterns had been identified as a promising approach to sustainable agriculture [7]. Encouraging crop diversity enabled farmers to minimize risks associated with climate change, pests, and diseases while optimizing resource use and enhancing overall resilience [9]. However, the adoption of sustainable agriculture practices in Nepal was influenced by various factors, including socio-economic conditions, access to resources, knowledge dissemination, and policy support [2, 8]. As a result, prioritizing the promotion of sustainable agriculture through effective policies and extension services was crucial for the government and development agencies [10]. Sustainable agriculture was a pressing need in Nepal to ensure food security and environmental protection. Implementing appropriate soil fertility management practices and promoting crop diversification were vital steps toward achieving these goals [7]. Addressing socio-economic and institutional barriers would pave the way for sustainable agricultural development in Nepal [3].

Birendranagar municipality had experienced intensive farming practices, leading to land degradation, declining soil fertility, and reduced organic matter content [7]. To ensure long-term food security and mitigate environmental degradation, gaining insights into current practices and developing strategies for enhancing agricultural productivity sustainably were imperative. For instance, a study conducted by Shrestha, A. et al. [7] in a neighboring region emphasized the need for diversifying cropping systems to improve soil health and reduce reliance on chemical inputs. Similarly, the FAO [4] highlighted the importance of sustainable land and water management practices in ensuring food security. The present study aimed to investigate the cropping patterns, agricultural practices, and soil fertility management in Birendranagar municipality, with a specific focus on nine wards. The findings from this research provided valuable insights into the current agricultural practices, including cropping patterns, landholding status, and fertilizer usage. These insights served as a foundation for developing strategies to improve soil fertility, enhance agricultural productivity, and promote sustainable farming practices in Birendranagar municipality, thereby contributing to long-term food security and the well-being of the community.

2. Methodology

The methodology included research design, sample size, sampling procedure, data collection tools, and data analysis techniques. The study employed a descriptive research design and utilized a mixed-methods approach, combining quantitative and qualitative data collection and analysis.

2.1. Research Design

A mixed-methods research design was employed to investigate the cropping patterns and agricultural practices in Birendranagar, municipality. This approach allowed for a comprehensive exploration by integrating both quantitative and qualitative data.

2.2. Sample Size and Sampling Procedure

The research focused on nine specific wards within Birendranagar municipality. To ensure relevance and representation, a purposive sampling technique was used to select participants who were essential to achieving the research objectives. The sample size was determined based on feasibility and desired representation, resulting in approximately 15 respondents from each ward and a total of 135 participants.

2.3. Data Collection

Structured questionnaires were utilized as the primary data collection tool, consisting of closed-ended and open-ended questions. The questionnaires were designed to gather information on various aspects, including landholding status, cropping patterns, agricultural practices, and sources of fertilizers and organic manures. Before the actual data collection, a pilot study was conducted to refine and enhance the clarity of the questionnaire.

In addition to the questionnaires, qualitative data were collected through semi-structured interviews and focus group discussions with key informants such as local farmers, agricultural experts, and community leaders. These qualitative methods provided valuable insights into the underlying factors influencing cropping patterns and agricultural practices.

2.4. Data Collection Procedure

The data collection procedure involved a combination of face-to-face interviews and virtual methods. Informed consent was obtained from all participants before conducting interviews or collecting data. Throughout the data collection process, the researchers provided support and clarification to ensure accurate and reliable responses.

2.5. Data Analysis

The collected data underwent meticulous analysis using appropriate statistical and qualitative techniques. Quantitative data were analyzed using descriptive statistics, such as frequencies, percentages, and means, to summarize and identify patterns. Qualitative data were subjected to thematic analysis to identify recurring themes and patterns within the responses. The integration of findings from both quantitative and qualitative analyses provided a comprehensive understanding of the cropping patterns and agricultural practices in Birendranagar, municipality.

2.6. Data Validation

Several measures were implemented to enhance the validity and reliability of the collected data. Cross-checking responses for consistency, regular meetings to discuss discrepancies and a pilot study were conducted to validate the research instruments and ensure the accuracy of the data.

2.7. Data Interpretation

The collected data were interpreted using thematic analysis for qualitative responses and statistical software for quantitative data. Qualitative responses were carefully reviewed, coded, and categorized into themes and sub-themes. Quantitative data were analyzed using descriptive statistics, inferential statistics, and graphical representations.

3. Result and Discussion

3.1. Land Holding Status

Among the wards, Ward 3 stands out with the highest average upland area of 15.72 kattha (±2.07), indicating a preference for upland cultivation in this area. Following closely behind is Ward 6, which has an average upland area of 13.59 kattha (±3.1). On the other hand, Ward 4 has the lowest average upland area of 9.30 kattha (±4.5), indicating relatively smaller agricultural plots in this ward. Ward 9 and Ward 5 also have relatively smaller upland areas, with averages of 9.84 kattha (±7.97) and 10.14 kattha (±3.9), respectively.

In terms of lowland holdings, Ward 4 boasts the highest average area of 13.5 kattha (±5.21), indicating a preference for lowland farming in this ward. Conversely, Ward 5 has the smallest average lowland area of 7.5 kattha (±3.10), suggesting limited availability or utilization of lowland resources for agriculture. Considering the overall land holdings, Ward 3 has the highest average total land area of 25.82 kattha, followed by Ward 8 with 22.63 kattha, and Ward 2 with 23.36 kattha. On the other hand, Ward 5 and Ward 7 have relatively lower total land holdings, with averages of 17.64 kattha and 18.79 kattha, respectively.

Table 1. *Land holding of the research locates in Birendranagar, Surkhet.*

Ward No.	Upland	Lowland	Total
1	12.53 ±5.06	9.73±5.22	22.26
2	11.83±5.98	11.53±4.13	23.36
3	15.72 ±2.07	10.1±3.15	25.82
4	9.30±4.5	13.5±5.21	22.8
5	10.14±3.9	7.5±3.10	17.64
6	13.59±3.1	9.6±5.91	23.19
7	10.71±4.58	8.08±4.33	18.79
8	13.33±7.58	9.3±6.13	22.63
9	9.84±7.97	10.63±5.32	20.47
Total	11.88	9.99	21.87

Note: Figure after ± indicates standard deviation; 1 kattha = 0.033 hectare

3.2. Cropping Pattern

The data from Table 2 revealed varying cropping patterns across different wards of Birendranagar, Surkhet in 2021. These patterns were influenced by factors such as land type, availability of irrigation canals or rainfall water, and individual farmer preferences. Among the various wards, Ward Number 4 had the highest adoption rate of the Maize-Legume-Vegetable pattern, with 10 farmers (66.66%) following this cropping sequence. Ward Number 5 predominantly practiced the Maize-Paddy-Legume pattern, with 6 farmers (40%) adopting it. Ward Number 6 showed a significant preference for the Maize-Legume-Vegetable pattern, with 7 farmers (46.66%) practicing it. In terms of the Paddy-Wheat-Maize cropping pattern, Ward Number 3 had the highest number of farmers (9) following this sequence, accounting for 60% of the total farmers in that ward. Ward Number 1 and Ward Number 2 had 3 farmers (20%) each adopting the Paddy-Wheat-Maize pattern. Ward Number 8 also showed a notable preference for this pattern, with 8 farmers (53.33%) practicing it. The Paddy-Legume-Fallow pattern was most prevalent in Ward Number 3, with 4 farmers (26.66%) adopting it. Ward Number 7 also had a significant number of farmers (4) following this sequence, accounting for 26.66% of the total farmers in that ward. Other cropping patterns were observed among farmers across different wards, indicating their diversity in agricultural practices.

Table 2. *The cropping pattern of the Birendranagar, Surkhet.*

Ward Number	Maize-Legume-Vegetable	Maize-Paddy-Legume	Paddy-Legume-Fallow	Paddy-Wheat-Maize	Others	Total
1	8 (53.33)	0	0	3 (20)	4 (26.66)	15 (11.11)
2	3 (20)	2 (13.33)	0	5 (33.33)	5 (33.33)	15 (11.11)
3	0	0	4 (26.66)	9 (60)	2 (13.33)	15 (11.11)
4	10 (66.66)	0	0	5 (33.33)	0	15 (11.11)
5	3 (20)	6 (40)	0	0	6 (40)	15 (11.11)
6	7 (46.66)	2 (13.33)	3 (20)	0	3 (20)	15 (11.11)
7	0	9 (60)	4 (26.66)	0	2 (13.33)	15 (11.11)
8	3 (20)	0	0	8 (53.33)	4 (26.66)	15 (11.11)
9	5 (33.33)	4 (26.66)	0	6 (40)	0	15 (11.11)
Total	39 (28.88)	23 (17.03)	11 (8.14)	36 (26.66)	26 (19.25)	135 (100)

Note: The figure in parenthesis indicates the percentage

3.3. Source of Fertilizers

Table 3 revealed that the majority of cases in all wards preferred a combination of organic and inorganic fertilizers. Ward No. 4 had the highest proportion of cases (46.66%) that utilized organic fertilizers, followed by Ward No. 8 (26.66%) and Ward No. 7 (20%). Interestingly, none of the cases in any ward relied solely on inorganic fertilizers. The use of organic fertilizers exclusively was highest in Ward No. 2, with a percentage of 13.33%, followed by Wards No. 3 and 6, both with the same percentage (13.33%).

Moreover, the distribution of cases using both organic and inorganic fertilizers varied across the wards. Ward No. 1 had the highest proportion (73.33%), followed by Ward No. 3 (66.66%). The majority of respondents in Birendranagar, Surkhet favored a combination of organic and inorganic fertilizers. Ward No. 1 had the highest percentage of farmers (73.33%) using both sources, while Ward No. 4 stood out for its preference for organic fertilizers (46.66%).

Table 3. *Major Source of fertilizer of the Birendranagar, Surkhet.*

Ward No.	Organic	Inorganic	Both	Organic/Inorganic/Green manure	Total
1	0	0	11 (73.33)	4 (26.66)	15 (11.11)
2	2 (13.33)	0	9 (60)	4 (26.66)	15 (11.11)
3	2 (13.33)	0	10 (66.66)	3 (20)	15 (11.11)
4	7 (46.66)	0	4 (26.66)	4 (26.66)	15 (11.11)
5	0	0	6 (40)	9 (60)	15 (11.11)
6	*2* (13.33)	0	5 (33.33)	8 (53.33)	15 (11.11)
7	3 (20)	0	7 (46.66)	5 (33.33)	15 (11.11)
8	4 (26.66)	0	2 (13.33)	9 (60)	15 (11.11)
9	0	0	12 (80)	3 (20)	15 (11.11)
Total	20 (14.81)	0	66 (48.88)	49 (36.29)	135 (100)

Note: The figure in parenthesis indicates the percentage

3.4. Source of Organic Manures

The study found that the majority of farmers, accounting for 69.62%, preferred to use Farm Yard Manure (FYM) as their primary source of organic manure. Poultry manure was the second most popular choice, utilized by 39.99% of the farmers, followed by goat/sheep manure, which was used by 29.62% of the farmers. Compost was employed by 23.07% of the farmers, while pig manure and slurry were used by only a small percentage, 8.88%.

The distribution of organic manure sources varied among the different wards of Birendranagar. Ward number eight had 100% of the respondents using FYM as their source of organic fertilizer. In ward number two, five, and six, the percentage of farmers using FYM was 73.33% and 53.33% respectively. In ward number one, the majority of farmers (86.6%) relied on FYM, while poultry manure and compost were used by only 20% of the farmers, and goat/sheep manure and compost were not used at all. Ward number seven had the highest percentage of farmers utilizing poultry manure (73.33%), while Ward number six reported no usage of poultry manure. Farmers from ward number four and nine used all available sources of organic manure. In contrast, none of the respondents from ward number one, two, three, five, six, and eight used pig manure and slurry. The utilization of other sources such as poultry manure, goat/sheep manure, compost, pig manure, and slurry varied among the different wards, indicating the influence of local preferences and availability of resources.

Table 4. *Source of Organic manures of the Birendranagar, Surkhet.*

Ward No.	FYM	Poultry Manure	Goat/ Sheep Manure	Compost	Pig manure/slurry
1	13 (86.66)	3 (20)	0	3 (20)	0
2	11 (73.33)	6 (40)	2 (13.33)	5 (33.33)	0
3	10 (66.66)	8 (53.33)	4 (26.66)	3 (20)	0
4	8 (53.33)	7 (46.66)	9 (60)	2 (13.33)	5 (33.33)
5	11 (73.33)	9 (60)	5 (33.33)	0	0
6	8 (53.33)	0	10 (66.66)	5 (33.33)	0
7	9 (60)	11 (73.33)	0	3 (20)	4 (26.66)
8	15 (100)	4 (26.66)	3 (20)	0	0
9	9 (60)	6 (40)	7 (46.66)	11 (73.33)	3 (20)
Total	94 (69.62)	54 (39.99)	40 (29.62)	32 (23.07)	12 (8.88)

Note: The figure in parenthesis indicates the percentage.

3.5. Use of Chemical Fertilizer for Cauliflower, Potato and Radish

The application rates of chemical fertilizers varied across different wards for each vegetable in Birendranagar municipality. The primary chemical fertilizers used were Urea, DAP, and MOP. Among the three fertilizers, Urea and DAP were more commonly used compared to MOP.

For cauliflower cultivation, the highest application rates of

Urea, DAP, and MOP were observed in ward number eight, with 68.91 kg, 59.51 kg, and 7.14 kg per hectare (ha) of agricultural land, respectively. In contrast, ward number three had the lowest application rates, with 43 kg of Urea per ha. The application rate of DAP was the lowest in ward number one, with only 30.30 kg.

Regarding potato farming, ward number five had the highest application rates of Urea, DAP, and MOP, with 67.47 kg, 59.82 kg, and 4.02 kg per ha, respectively. Ward numbers nine and three had lower rates of Urea, receiving 35.33 kg and 39.55 kg per ha, respectively. MOP was not used in potato cultivation in wards one, four, nine, and six.

In radish production, ward number seven had the highest application rates of Urea, DAP, and MOP, with 66.02 kg, 50.33 kg, and 5.01 kg per ha, respectively. Conversely, ward number six and three had the lowest application rates, with 47.86 kg of Urea and 31 kg of DAP per ha, respectively. MOP was not used in radish production inwards five and six.

It was evident that there were significant variations in the application rates of Urea, DAP, and MOP across different wards for each vegetable. The highest and lowest rates differed among the wards for each type of fertilizer and vegetable. Moreover, MOP either had minimal usage or was not used at all in certain wards for all three vegetables.

Table 5. *The major source of Chemical fertilizers of the Birendranagar, Surkhet.*

Vegetables										
Ward Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Total**
Cauliflower										
Urea	59.66±22.1	54.51±4.3	43.00±3.71	73.21±2.9	47.00±5.77	52.32±2.11	48.33±7.33	68.91±3.21	61.86±7.1	56.53
DAP	30.30±4.35	47.10±2.3	32.00±1.94	53.03±2.5	31.00±2.21	38.31±1.20	58.21±3.01	59.51±2.92	49.33±3.07	44.3
MOP	5.01±3.98	7.02±2.91	0.00±0.00	2.41±0.91	2.30±2.34	0.00±0.00	5.48±1.28	7.14±1.21	4.05±1.01	3.71
Potato										
Urea	58.52±3.62	62.51±4.81	39.55±9.2	57.72±3.42	67.47±3.22	55.34±6.21	57.82±4.17	57.86±5.36	35.33±5.32	54.68
DAP	52.33±4.31	56.02±0.52	49.92±3.92	40.13±2.01	59.82±2.77	42.81±3.22	52.47±3.84	52.33±0.11	24.40±5.93	47.8
MOP	0.00±0.00	3.01±3.45	3.98±0.35	0.00±0.00	4.02±1.82	0.00±0.00	0.31±0.26	0.2±1.29	0.00±0.00	1.28
Radish										
Urea	53.00±3.71	48.33±7.33	55.32±3.92	45.34±6.21	52.33±5.31	47.86±5.36	66.02±0.12	56.51±4.81	50.33±5.32	52.78
DAP	39.42±3.92	52.55±9.2	31.00±2.21	42.61±0.91	53.30±2.34	44.31±1.20	37.10±2.3	43.00±3.71	54.51±4.3	44.2
MOP	0.98±0.35	2.61±0.91	7.14±1.21	5.64±1.21	0.00±0.00	0.00±0.00	3.21±3.45	5.01±3.98	0.31±0.66	2.766

Note: Figure after ± indicates standard deviation; 1 kattha = 0.033 hectare.

3.6. Sources of Green Manure

According to Table 6, the major sources of green manure used in the study area of Birendranagar, Surkhet were Dhaincha, Cowpea, and Sesamum. Farmers from ward number one, four, and five utilized all the available sources of green manure. In ward number one, 60% of farmers used Dhaincha, 20% used Sesamum, and 13.3% used Cowpea. Similarly, in ward number four, 40% of farmers used Dhaincha, 20% used Cowpea, and 13.33% used Sesamum. In ward number five, 46.6% of farmers used Dhaincha, 13.3% used Cowpea, and 26.66% used Sesamum.

Furthermore, ward number nine had the highest percentage of farmers using Dhaincha as their source of green manure, with 73.33% of farmers utilizing it. Ward number one had the second-highest usage of Dhaincha at 60%, followed by ward number two and seven at 53.33%, and wards three and five at 46.6%. The usage of Cowpeas was nil in ward number two, three, six, eight, and Nine, while 13.33% of farmers from wards number one and 20% from Wards four, five, and Seven used Cowpeas. The data from the table indicated that, on average, 48.8% of respondents used Dhaincha as the main source of green manure, followed by Sesamum at 15.55%, and Cowpea at only 7.4%. Therefore, it can be concluded that Dhaincha was the primary source of green manure used by farmers in Birendranagar municipality.

Table 6. *Source of green manure.*

Ward No.	**Green Manure**		
	Dhaincha	**Cowpea**	**Sesamum**
1	9 (60)	2 (13.33)	3 (20)
2	8 (53.33)	0	0
3	7 (46.66)	0	0
4	6 (40)	3 (20)	2 (13.33)
5	7 (46.66)	2 (13.33)	4 (26.66)
6	5 (33.33)	0	6 (40)
7	8 (53.33)	3 (20)	0
8	5 (33.33)	0	3 (20)
9	11 (73.33)	0	3 (20)
Total	66 (48.88)	10 (7.4)	21 (15.55)

Note: The figure in parenthesis indicates the percentage

3.7. Irrigation Facility

3.7.1. Availability of Irrigation

According to Table 7, the availability of irrigation facilities in Birendranagar, Surkhet varied among the different wards. None of the farmers in any ward had 100% access to irrigation. Ward number seven had the highest percentage of farmers (80%) who reported irrigating their fields based on crop needs, followed by ward number one with 60%. On the other hand, the majority of farmers in Ward number eight (80%) and wards six and Nine (66.66%) did not have any irrigation sources.

On average, 43.70% of farmers in the research site had access to irrigation facilities, while the remaining farmers did not have any access to irrigation and relied solely on rainfall. It could be observed that there was a significant disparity in the availability of irrigation facilities among the wards. Ward number seven had the highest percentage of farmers (80%) with access to irrigation, while Ward number eight had the lowest percentage (20%). Ward numbers two, four, and five had similar proportions of farmers with access to irrigation, ranging from 46.66% to 53.33%. In contrast, ward numbers three and six had lower percentages of farmers with access to irrigation, at 26.66% and 33.33% respectively.

Table 7. *Availability of irrigation facility in the Birendranagar, Surkhet.*

Ward number	Yes	No	Total
1	9 (60)	6 (40)	15 (11.11)
2	8 (53.33)	7 (46.66)	15 (11.11)
3	4 (26.66)	11 (73.33)	15 (11.11)
4	6 (40)	9 (60)	15 (11.11)
5	7 (46.66)	8 (53.33)	15 (11.11)
6	5 (33.33)	10 (66.66)	15 (11.11)
7	12 (80)	3 (20)	15 (11.11)
8	3 (20)	12 (80)	15 (11.11)
9	5 (33.33)	10 (66.66)	15 (11.11)
Total	59 (43.70)	76 (56.29)	135 (100)

Note: The figure in parenthesis indicates the percentage

3.7.2. Source of Irrigation

In Birendranagar, Surkhet, the major sources of irrigation were categorized as canal water, deep tube wells, shallow tube wells, surface water/rainfall, and other sources, according to Table 8. The data showed that the majority of farmers in the VDC relied on canal water (54%) as their primary source of irrigation. However, it was important to note that farmers in ward number eight did not have access to canal water for irrigation purposes.

In ward number seven, all farmers (100%) used canal water as their source of irrigation. Deep tube wells were utilized by only 3.70% of farmers as an irrigation source. Shallow tube wells were used by approximately 14.07% of respondents, while the majority of farmers in the study area relied on surface water or rainfall for irrigation. On average, about 22.96% of respondents depended on rainfall as a source of surface water for irrigation.

The data indicated that the usage of canal water varied across different wards. Ward numbers six and seven had the highest percentages of farmers using canal water for irrigation, with 80% and 100% respectively. Ward number three had the highest percentage of farmers (66.66%) using shallow tube wells, while Ward number eight had the highest percentage (60%) relying on surface water/rainfall for irrigation.

Table 8. *Major Source of Irrigation in Birendranagar, Surkhet.*

Ward No.	Canal	Deep tube well	Shallow tube well	Surface water/rainfall
1	10 (66.66)	0	3 (20)	2 (13.33)
2	8 (53.33)	2 (13.33)	0	4 (26.66)
3	5 (33.33)	0	5 (33.33)	10 (66.66)
4	7 (46.66)	3 (20)	0	4 (26.66)
5	9 (60)	0	3 (20)	2 (13.33)
6	12 (80)	0	2 (13.33)	0
7	15 (100)	0	0	0
8	0	0	4 (26.66)	9 (60)
9	7 (46.66)	0	2 (13.33)	0
Total	78 (54.07)	5 (3.70)	19 (14.07)	31 (22.96)

Note: The figure in parenthesis indicates the percentage

According to Table 9, the yield response of farmers after using fertilizers for vegetable crops in Birendranagar, Surkhet was categorized as sufficient and insufficient. The data showed that all farmers from ward number four reported a 100% insufficient vegetable yield after using fertilizers. On average, 70% of farmers experienced insufficient yields, while only 29% of farmers obtained sufficient yields in response to fertilizer usage.

The majority of farmers across all wards responded with insufficient vegetable yields after using fertilizers. The reasons behind this insufficiency were attributed to various factors such as the quality, dosage, timely availability, and application methods of fertilizers, as well as the quality and timeliness of seeds, lack of irrigation facilities, diseases, and soil conditions (texture, structure, etc.). Among these factors, the lack of irrigation facilities was identified as the major constraint, with 68% of farmers citing it as a contributing factor to insufficient yields. Fertilizers were also identified as a significant factor, with 57% of farmers indicating it as a constraint. The quality and timeliness of seeds were mentioned by 22% of farmers, diseases by 19%, and soil conditions by 10.36%.

Table 9. *Reason for poor vegetable yield in Birendranagar, Surkhet.*

Ward No.	Fertilizer	Seeds	Irrigation	Disease	Soil
1	7 (46.66)	3 (20)	10 (66.66)	3 (20)	0
2	8 (53.33)	6 (40)	6 (40)	2 (13.33)	2 (13.33)
3	5 (33.33)	2 (13.33)	11 (73.33)	5 (33.33)	5 (33.33)
4	8 (53.33)	9 (60)	12 (80)	0	4 (26.66)

Ward No.	Fertilizer	Seeds	Irrigation	Disease	Soil
5	9 (60)	0	11 (73.33)	5 (33.33)	0
6	9 (60)	5 (33.33)	9 (60)	6 (40)	0
7	12 (80)	0	10 (66.66)	0	2 (13.33)
8	10 (66.66)	3 (20)	11 (73.33)	3 (20)	1 (6.66)
9	9 (60)	2 (13.33)	12 (80)	2 (13.33)	0
Total	77 (63.7)	30 (22.22)	92 (68.14)	26 (19.25)	14 (10.36)

Note: The figure in parenthesis indicates the percentage

3.8. Climatic Hazard for Vegetable Production

Flooding emerged as the most prominent climatic hazard, with 52.58% of respondents facing problems. Ward nine had the highest percentage of farmers (100%) affected by flooding, indicating a severe impact on vegetable production in that area. Additionally, ward five (66.6%), ward two (60%), and ward three and Six (53% each) reported substantial challenges due to flooding. It is worth noting that even wards one and eight, although not among the most affected, still had 26.66% of farmers dealing with flooding issues.

Landslides were another significant climatic hazard, although with a relatively lower prevalence compared to flooding. The data showed that 9.62% of respondents faced landslides. Ward five had the highest percentage (26.66%) of farmers experiencing landslide-related problems. Wards two, six, and seven reported the same percentage (13.33%) of farmers dealing with landslides.

Erosion, the third climatic hazard mentioned, affected 14.81% of respondents. Ward one had the highest percentage (40%) of farmers reporting erosion issues, followed by wards three and eight, both with 33.33% of farmers affected. Erosion could lead to soil degradation and loss of topsoil, negatively impacting vegetable cultivation and productivity. About 22.96% of respondents reported no problems with climatic hazards for vegetable production. This indicated that a significant portion of farmers in Birendranagar were located in areas less prone to these hazards or had implemented effective mitigation measures.

Table 10. *Climatic hazard for vegetable production in Birendranagar, Surkhet.*

Ward No.	Landslide	Flooding	Erosion	No Hazard	Total
1	0	4 (26.66)	6 (40)	5 (33.33)	15 (11.11)
2	2 (13.33)	9 (60)	0	4 (26.66)	15 (11.11)
3	0	8 (53.33)	5 (33.33)	2 (13.33)	15 (11.11)
4	4 (26.66)	7 (46.66)	0	4 (26.66)	15 (11.11)
5	3 (20)	10 (66.66)	2 (13.33)	0	15 (11.11)
6	2 (13.33)	8 (53.33)	0	5 (33.33)	15 (11.11)
7	2 (13.33)	6 (40)	2 (13.33)	5 (33.33)	15 (11.11)
8	0	4 (26.66)	5 (33.33)	6 (40)	15 (11.11)
9	0	15 (100)	0	0	15 (11.11)
Total	10 (9.62)	71 (52.58)	20 (14.81)	31 (22.96)	135 (100)

Note: The figure in parenthesis indicates the percentage

3.9. Routine Soil Analysis

In the study area, farmers had limited knowledge about soil analysis, but they mentioned that soil samples were analyzed by a project approximately three years ago. The analysis recommended the application of agricultural lime (CaCO3) to benefit vegetable production in Birendranagar, Surkhet. This suggests that soil acidity might have been a concern. Routine soil analysis is important for farmers as it provides valuable information about soil properties and nutrient content, enabling informed decisions about fertilizer application and soil amendments. Promoting awareness and providing training on soil testing can empower farmers to optimize soil fertility and improve vegetable production in the long term.

4. Conclusion

The study revealed variations in landholding status among different wards, with Ward 3 having the highest average upland area and Ward 4 having the highest average lowland area. This indicates differences in agricultural potential and land utilization within the municipality. Diverse cropping patterns were identified, including sequences such as Maize-Legume-Vegetable and Paddy-Wheat-Maize. These cropping patterns were influenced by factors such as land type, availability of irrigation canals or rainfall water, and individual farmer preferences. The presence of different cropping patterns indicates the diversity in agricultural practices within the municipality. Farmers in Birendranagar municipality used a combination of organic and inorganic fertilizers, with a preference for organic fertilizers observed in Ward 4. Farm Yard Manure was the primary source of organic manure, followed by poultry and goat/sheep manure. This suggests that farmers in the municipality recognize the importance of organic inputs for soil fertility management. The study emphasizes the need for sustainable land and water management practices to address the challenges of land degradation and declining soil fertility. Strategies should be

developed to promote sustainable farming practices, enhance agricultural productivity, and ensure long-term food security in the municipality.

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