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Socio-economic analysis of off-season cabbage cultivation in hill horticulture system of Manipur

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Abstract

Off-season vegetable cultivation has emerged as a key livelihood strategy in hill agriculture systems of North-Eastern India, particularly under conditions of fragmented landholdings and limited livelihood diversification options. The study was conducted in Manipur with a focus on off-season cabbage cultivation in Senapati district. The objective was to analyse the socio-economic characteristics of cabbage growers and the structural features of their farming system. A multistage sampling design was adopted, and 80 respondents were selected, comprising 49 marginal farmers (61.25%) and 31 small farmers (38.75%), using simple random sampling with proportional allocation. Primary data were collected through a structured interview schedule covering age, education, family size, landholding pattern, occupation, and farming experience. The results revealed that the majority of respondents belonged to the middle-aged group (approximately 55–60%), followed by young and old categories. A significant proportion of farmers had education up to primary and secondary level (around 70–75%), indicating moderate literacy among cabbage growers. Most households were characterized by medium family size (about 60–65%), which supports the labour-intensive nature of off-season cabbage cultivation. Agriculture was identified as the primary occupation for more than 80% of respondents, reflecting high dependence on farming for livelihood. The findings indicated that off-season cabbage cultivation plays an important role in income generation, employment creation, and livelihood stability among smallholder farmers in hill regions. However, structural constraints related to input access, market fluctuations, and extension support continue to limit productivity and profitability. Strengthening market infrastructure, ensuring timely availability of quality inputs, and enhancing targeted extension services are essential for improving the efficiency and sustainability of off-season cabbage-based livelihood systems in Manipur. Focused policy support for hill horticulture can significantly enhance income security and rural development outcomes.

Keywords: Off-season vegetable cultivation, cabbage cultivation, hill agriculture, livelihood strategy

Introduction

Vegetable cultivation constitutes a critical component of global agricultural systems owing to its contribution towards food security, nutritional adequacy, employment generation, and income diversification. Among the wide range of vegetable crops cultivated across the world, cabbage (*Brassica oleracea* var. *capitata*) occupies a significant position due to its high nutritional value, wide adaptability, relatively shorter duration, and commercial importance. Cabbage is recognized as an excellent source of vitamins C and K, dietary fibre, antioxidants, and essential micronutrients, thereby playing an important role in combating micronutrient deficiencies and promoting dietary diversification (Aune *et al.*, 2017) ^[1]. The crop has also gained substantial economic importance because of its year-round demand, suitability for intensive cultivation, and integration into both subsistence and market-oriented

farming systems.

Globally, cabbage is cultivated extensively in temperate, subtropical, and tropical agro-ecological regions, with Asia accounting for the dominant share of global area and production. According to FAOSTAT (2023) ^[5], global cabbage and brassica production exceeded 71 million tonnes, with China contributing nearly half of the total world production, followed by India, South Korea, Russia, and Japan. The rapid expansion of vegetable consumption driven by urbanization, rising incomes, and changing dietary preferences has considerably increased the commercial relevance of cabbage cultivation in developing countries (Pingali, 2015) ^[9]. Furthermore, cabbage has emerged as a preferred crop among smallholders because of its comparatively high productivity, lower gestation period, and regular market demand throughout the year.

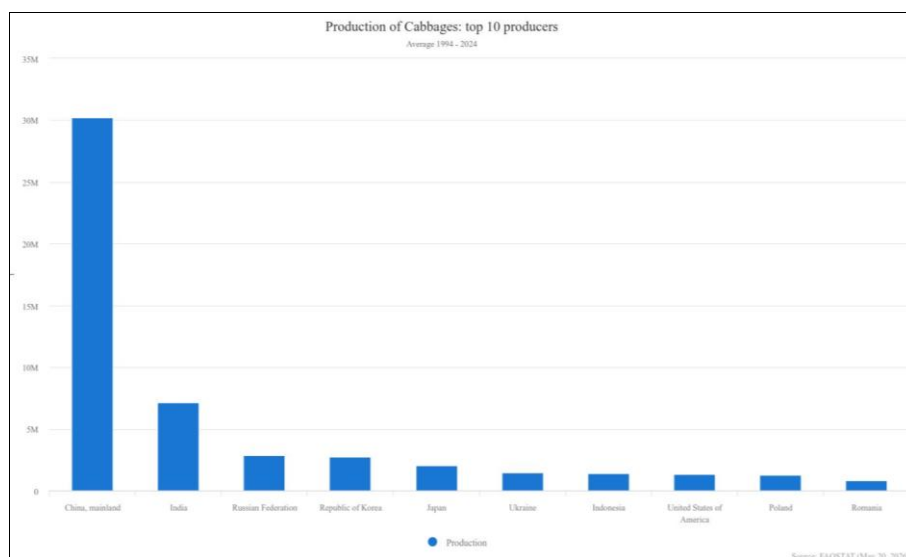


Fig 1: Top Global Producers of Cabbage (Average Production, 1994–2024)

Source: Food and Agriculture Organization Statistical Database (FAOSTAT), 2024 ^[5].

Average cabbage production among the top producing countries during the period 1994–2024 observed that China remained the dominant producer with an average production exceeding 30 million tonnes, accounting for a substantial share of global cabbage output. India ranked second with production of nearly 7 million tonnes, reflecting the growing importance of cabbage cultivation within the Indian horticultural sector. Other major producers included the Russian Federation and the Republic of Korea, each contributing around 2–3 million tonnes annually. Countries such as Japan, Ukraine, Indonesia, the United States of America, Poland, and Romania also maintained significant levels of cabbage production, although at comparatively lower scales. The figure highlights the strong concentration of cabbage production within Asian countries, indicating the crop's importance in Asian food systems, vegetable markets, and smallholder farming economies. The comparatively high production levels observed in China and India further demonstrate the increasing role of vegetable cultivation in ensuring nutritional security and income generation in developing economies.

In South and Southeast Asia, cabbage cultivation forms an integral component of commercial horticulture and peri-urban vegetable supply systems. The crop is particularly important in hill and upland agro-ecosystems where favourable climatic conditions support off-season cultivation and market supply during lean production periods. Off-season vegetable cultivation has been widely recognized as an effective strategy for enhancing farm income and improving livelihood resilience among smallholder farmers due to the price advantages associated with seasonal scarcity (Birthal *et al.*, 2015) ^[4]. Studies have shown that commercialization of high-value vegetables contributes significantly to employment generation, rural income growth, and market integration in Asian farming systems (Joshi *et al.*, 2007) ^[7].

India ranks among the leading cabbage-producing countries in the world and has witnessed substantial expansion in vegetable cultivation over the past two decades. The horticulture sector currently contributes significantly to

agricultural gross value added (GVA), with vegetable crops occupying a central role in income-oriented smallholder farming systems. According to the National Horticulture Board (2023) ^[8], cabbage and other cole crops are cultivated extensively across different agro-climatic regions of India due to their high market demand and profitability. The increasing shift from cereal-dominated production systems towards high-value horticultural crops reflects changing consumption patterns, improved market access, and greater economic returns from vegetable cultivation (Birthal, Joshi, & Gulati, 2005) ^[3].

The North Eastern Region (NER) of India possesses considerable comparative advantage for off-season vegetable cultivation because of its favourable agro-climatic conditions, high rainfall, moderate temperatures, and rich biodiversity. Agriculture in the region is predominantly characterized by smallholder production systems with a strong dependence on horticultural crops for livelihood support and income diversification. Vegetable cultivation has emerged as an important pathway for enhancing rural employment and market participation in the hill ecosystems of Northeast India (Baruah & Bose, 2022) ^[2]. In particular, off-season cabbage cultivation provides farmers with opportunities to access distant urban markets during periods of low supply, thereby generating relatively higher returns compared to seasonal cultivation.

Despite its economic importance, off-season cabbage cultivation in Manipur continues to be dominated by resource-constrained smallholder farmers operating under limited access to technology, institutional support, quality inputs, and efficient marketing systems. Small operational holdings, dependence on family labour, and weak market linkages often influence production efficiency and profitability. Previous studies have emphasized that socio-economic characteristics such as education, farm size, labour availability, and household demographic composition significantly influence technology adoption, resource utilization, and market participation among vegetable growers (Feder, Just, & Zilberman, 1985; Rahman & Akter, 2014) ^[6, 10]. Therefore, understanding the socio-economic profile of off-season cabbage growers becomes essential for designing appropriate interventions aimed at improving

productivity, livelihood security, and sustainability of vegetable-based farming systems.

Table 1: Area, Production & Productivity of Cabbage in Manipur (2022–23)

S. No	District	Area (ha)	Production (MT)	Productivity (MT/ha)
1	Imphal East	1120	13600	12.14
2	Imphal West	980	11700	11.94
3	Bishnupur	1180	15000	12.71
4	Thoubal	1060	13400	12.64
5	Kakching	620	7800	12.58
6	Senapati	820	9300	11.34
7	Ukhrul	540	6200	11.48
8	Chandel	310	3600	11.61
9	Tamenglong	280	3100	11.07
10	Churachandpur	350	4200	12.00
Total		7260	87900	12.11

Government of Manipur. (2023).

In this context, the study attempted to examine the socio-economic characteristics and structural composition of off-season cabbage-growing households in Manipur. The study sought to provide empirical insights into computing Compound Annual Growth Rate of Manipur state on cabbage statistics, socio-economic profile that included farm structure, labour participation, family composition, educational status, and landholding patterns associated with off-season cabbage cultivation. The findings contribute towards strengthening policy support for sustainable vegetable production and enhancing the livelihood resilience of smallholder farming households in the region.

2. Methodology

2.1 Selection of study Area and Respondents

The present study was conducted in Manipur, a northeastern state of India located between 92°58'23.422"–94°43'35.553" E longitude and 23°49'45.530"–25°42'1.456" N latitude. The state is characterized by a central valley surrounded by hill ranges, which strongly influence its agro-climatic conditions and farming systems. Manipur shares an international boundary of about 352 km with Myanmar and is bordered by Nagaland, Assam, and Mizoram. The total geographical area is 22,327 km², of which nearly 90 percent is hilly terrain and 10 percent is valley. The state receives an average annual rainfall of about 1137.1 mm (ICAR, Lamphelpat), supporting diverse agricultural production. Major crops include rice, maize, cabbage, cauliflower, peas, potato, beans, tomato, mustard, and several fruit crops such as orange, lemon, and banana. The state is administratively divided into nine districts, comprising four valley districts (Imphal East, Imphal West, Bishnupur, Thoubal) and five hill districts (Senapati, Tamenglong, Churachandpur, Chandel, Ukhrul). The hill districts are particularly suitable for off-season vegetable cultivation due to favourable climatic conditions.

The study was carried out in the hill region of Manipur, where off-season cabbage cultivation is concentrated. Senapati district was purposively selected due to its higher production potential and larger cultivated area. The district comprises seven blocks, of which Mao-Maram and Paomata were selected purposively based on the intensity of cabbage cultivation.

From these blocks, four villages-Makuilongdi and Punanamei (Mao-Maram), and Laii and Tungjoy (Paomata) were selected based on the concentration of cabbage growers, with information obtained from KVK, Senapati. A complete list of farmers was prepared for each village, and 80 respondents were selected using simple random sampling with proportional allocation. This ensured representation across villages based on the distribution of cabbage growers. The multistage sampling framework adopted in the study ensured systematic selection of respondents and provided a representative basis for analyzing the constraints faced by off-season cabbage growers in the hill region of Manipur.

2.2 Analytical Tools

2.2.1 Compound Annual Growth Rate (CAGR)

The growth performance of cabbage production in Manipur was analyzed using a log-linear regression model to estimate the compound growth rate over time. The model is widely used in agricultural economics as it captures exponential growth patterns and provides a direct interpretation of growth rates.

The following functional form was employed:

$$\ln(P_t) = \alpha + \beta t$$

where P_t represents cabbage production in year t , α is the intercept, β is the time trend coefficient, and t denotes the time index (2012–2022). The annual compound growth rate was derived as:

$$g = (e^\beta - 1) \times 100$$

The model was estimated using Ordinary Least Squares (OLS) based on secondary time-series data obtained from the Directorate of Economics and Statistics (DES), Government of Manipur and Indiatat database.

2.2.2 Descriptive Statistical Analysis

Descriptive statistical measures such as frequencies, percentages, averages, and ratios were employed to examine the demographic and socio-economic characteristics of sample households. These measures facilitated the assessment of farm structure, labour composition, educational attainment, family composition, and landholding distribution among different categories of farmers.

Percentage analysis was used to study proportional distribution of respondents under various socio-economic categories and was estimated using the following expression:

$$\text{Percentage} = \frac{\text{Number of respondents in a category}}{\text{Total number of respondents}} \times 100$$

Arithmetic mean was employed to estimate average family size, operational holding, and labour availability among sampled farm households.

$$\bar{X} = \frac{\sum X}{N}$$

Where:

$\bar{X}$ = Arithmetic mean

$\sum X$ = Summation of observations

N = Number of observations

2.2.3 Dependency Ratio Analysis

In order to assess demographic pressure and household dependency burden within the sampled farming households, dependency ratio analysis was carried out. The dependency ratio serves as an important socio-economic indicator reflecting the proportion of dependent population relative to economically active household members.

For the present study, children were considered as dependent population, whereas adult household members constituted the working-age population. The dependency ratio was estimated using the following formula:

$$\text{Dependency Ratio} = \frac{\text{Dependent Population}}{\text{Working-age Population}} \times 100$$

A higher dependency ratio indicates relatively greater economic pressure on earning household members and may influence labour allocation, household expenditure patterns, savings behaviour, and livelihood sustainability in smallholder farming systems.

2.2.4 Labour Participation Analysis

Labour participation analysis was undertaken to examine the gender-wise composition of labour engaged in off-season cabbage cultivation. Male and female labour participation was estimated as a proportion of total labour utilization in sampled farms. The analysis facilitated understanding of family labour dependence and gender contribution within labour-intensive vegetable production systems.

2.2.5 Data Collection

The collected data were thoroughly scrutinized for completeness, consistency, and reliability prior to analysis. The analyzed results were presented through tabular and graphical forms to facilitate clear interpretation and meaningful discussion of socio-economic characteristics associated with off-season cabbage cultivation systems.

3. Results and Discussion

3.1 Compound Annual Growth Rate of Cabbage in Manipur from 2012-2022

The results indicated a steady expansion in the area under cabbage cultivation from 6.10 thousand hectares in 2012 to 7.55 thousand hectares in 2022. Similarly, production increased from 63.80 thousand tonnes to 101.37 thousand tonnes during the same period. Productivity also improved from 10.46 tonnes per hectare to 13.43 tonnes per hectare, reflecting gradual technological improvement, better agronomic practices, and increased adoption of improved varieties.

Table 2: Manipur Cabbage: Area, Production & Productivity (2012–2022)

Year	Area (ha)	Production (MT)	Productivity (MT/ha)
2012-13	7150	84500	11.82
2013-14	7280	86250	11.85
2014-15	7590	90704	11.95
2015-16	7710	92500	12.00
2016-17	7900	96000	12.15
2017-18	8120	100500	12.38
2018-19	8250	104200	12.63
2019-20	8371	107969	12.90
2020-21	7109	110891	15.59
2021-22	7350	114200	15.53
2022-23	7480	118000	15.78

Trend in Cabbage Production

The log-linear regression analysis revealed a strong and statistically stable upward trend in cabbage production in Manipur during the period 2012–2022. The estimated coefficient of time (β) was found to be 0.0452, indicating a positive exponential growth pattern.

The implied compound annual growth rate was calculated at approximately 4.62 percent per annum, confirming steady expansion in cabbage output over the study period. The model exhibited an exceptionally high explanatory power with an R^2 value of 0.997, indicating that nearly all variation in production was explained by the time trend.

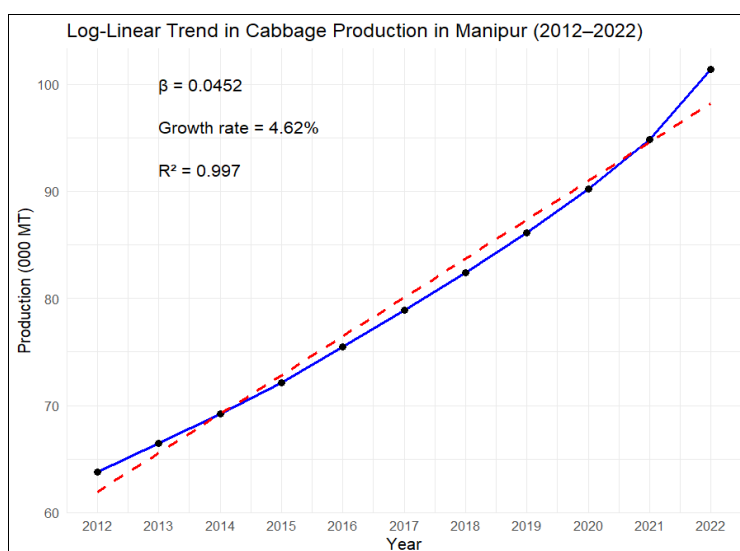


Fig 2: Estimated Log-Linear Growth Trend of Cabbage Production in Manipur (2012–2022)

The figure illustrates both the observed production values (solid blue line) and the fitted log-linear trend (red dashed line) for cabbage production in Manipur. The close alignment between observed and predicted values indicates a strong goodness of fit, confirming a stable exponential growth trajectory.

The estimated trend coefficient ($\beta = 0.0452$) corresponds to an annual growth rate of 4.62 percent, which closely aligns with the earlier CAGR estimate of approximately 4.8 percent. The high R^2 value (0.997) further validates the robustness of the model, indicating that production growth in Manipur followed a highly deterministic upward trend over the study period rather than random fluctuations.

Overall, the results confirm that cabbage production in Manipur exhibited a consistent and sustained exponential growth pattern driven by structural expansion in horticultural activity and gradual improvements in productivity.

3.2 Socio-economic Characteristics of Sample Off-Season Cabbage Farms

Socio-economic characteristics of farm households play an important role in determining the production behaviour, resource utilization pattern, labour allocation, and adoption of improved cultivation practices in agriculture. Variables such as farm size, family composition, age structure, educational status, and labour availability significantly influence farm management decisions and market participation. In the context of off-season cabbage cultivation, these characteristics become particularly important due to the labour-intensive and market-oriented nature of vegetable production systems. Therefore, an attempt was made to examine the socio-economic characteristics of sample off-season cabbage growers in the study area.

To provide a broader understanding of the sampled households, summary statistics of selected socio-economic variables were estimated and presented in Table 2. The results indicate that the average age of sampled farmers was 43.90 years, suggesting the predominance of middle-aged farmers in off-season cabbage cultivation. The mean family size was estimated at 7.44 persons, reflecting relatively large rural households with considerable family labour availability. The average labour availability per household was 4.08 persons, indicating the labour-intensive nature of off-season vegetable cultivation. Further, the average operational holding size was estimated at 0.90 ha, confirming the predominance of smallholder farming systems in the study area. The observed variation across operational holdings and labour availability reflects differences in resource endowment among farm households.

Table 3: Summary Statistics of Sample Off-Season Cabbage Farms

Variable	Mean	Standard Deviation	Minimum	Maximum
Age of farmer (years)	43.90	11.80	22	69
Family size (persons)	7.44	2.24	2	11
Labour availability (persons)	4.08	1.46	2	7
Operational holding (ha)	0.90	0.30	0.30	1.60

3.2.1 Farm Size and Labour Composition of Off-Season Cabbage Sample Farms

Farm size plays a crucial role in determining the production potential, labour utilization, and economic viability of farm households. The size of operational holdings directly influences input use, cropping decisions, and market participation in vegetable cultivation systems. The distribution of sample farms according to operational holding size and labour composition is presented in Table 3. The study revealed that marginal farms constituted the major share of the sample with 49 farms, while 31 farms belonged to the small farm category. The total operational holding of sampled farms was estimated at 72.23 ha, of which marginal and small farms accounted for 35.08 ha and 37.15 ha, respectively. The average farm size was estimated at 0.90 ha, indicating the predominance of smallholder-based off-season cabbage cultivation in the study area. The average operational holding size was relatively higher on small farms (1.19 ha) compared to marginal farms (0.71 ha). Labour utilization patterns indicated substantial dependence on both male and female labour participation. The total number of farm workers employed across all sampled farms was 459, comprising 245 male workers (53.37%) and 214 female workers in male-equivalent terms (46.62%). Female labour participation was relatively higher on small farms (52.33%) compared to marginal farms (47.66%), indicating the significant contribution of women to off-season cabbage cultivation activities. The findings suggest that off-season cabbage cultivation is highly labour-intensive and depends considerably on family as well as hired labour for various farm operations.

Overall, the dominance of marginal and small holdings reflects the prevalence of resource-constrained smallholder vegetable production systems in the study area, where labour availability and efficient resource management play a crucial role in sustaining productivity and farm income.

Table 4: Farm Size and Labour Composition of Off-Season Cabbage Sample Farms

Sl. No.	Particulars	Marginal Farms	Small Farms	Overall
1	Number of farms	49	31	80
2	Total operational holding (ha)	35.08	37.15	72.23
3	Average farm size (ha)	0.71	1.19	0.90
4	Farm workers			
i	Male workers	124 (50.61)	121 (49.38)	245 (53.37)
ii	Female workers (male equivalent)	102 (47.66)	112 (52.33)	214 (46.62)
5	Total workers	226 (100)	233 (100)	459 (100)

Note: Figure in parentheses denotes the percentage to the respective total

3.2.2 Family Size and Composition of Off-Season Cabbage Sample Farmers

Family composition plays an important role in determining labour availability, consumption requirements, and resource allocation within farm households. In labour-intensive crops such as off-season cabbage, family size and the proportion of working members significantly influence farm management and cultivation practices. The distribution of

family composition among sampled farm households is presented in Table 4.

The results revealed that the average family size of sampled households was 7.44 persons, indicating relatively large rural family structures in the study area. The average family size was comparatively higher on small farms (9.58 persons) than on marginal farms (6.08 persons). The total family population across sampled households was estimated at 595 persons, of which 297 belonged to small farms and 298 to marginal farms.

The composition of family members showed a relatively balanced distribution between children and adults. Among marginal farm households, adult members accounted for 55.02 per cent of the total family population, comprising 31.20 per cent adult males and 23.82 per cent adult females. Similarly, adults constituted 54.53 per cent of the family population on small farms, including 30.63 per cent adult males and 23.90 per cent adult females. The proportion of children was relatively lower compared to adults across both farm categories.

The higher proportion of adult family members indicates greater availability of family labour for agricultural operations, which is particularly important in off-season vegetable cultivation where labour requirements are relatively high. The findings suggest that family labour continues to play a crucial role in sustaining smallholder cabbage production systems in the study area.

Table 5: Family Size and Composition of Sample Farm Families of Off-Season Cabbage Growers

Sl. No.	Particulars	Marginal Farms	Small Farms	Overall
1	Number of households	49	31	80
	Average family size	6.08	9.58	7.44
2	Children			
	Male	69 (23.15)	65 (21.88)	134 (22.52)
	Female	65 (21.81)	70 (23.56)	135 (22.68)
3	Adults			
	Male	93 (31.20)	91 (30.63)	184 (30.92)
	Female	71 (23.82)	71 (23.90)	142 (23.86)
4	Total family size	298 (100)	297 (100)	595 (100)
5	Average family size	6.08	9.58	7.44

Note: Figures in parentheses indicate percentage to the respective total

3.2.3 Age Distribution of Off-Season Cabbage Farmers

Age composition of farmers is an important socio-economic indicator influencing decision-making ability, risk-bearing capacity, labour efficiency, and adoption of improved cultivation practices. The age-wise distribution of sampled off-season cabbage farmers is presented in Table 5.

The results indicated that the majority of sampled farmers belonged to the economically active middle-age categories. Among marginal farms, the highest proportion of farmers (34.69%) belonged to the 35–45 years age group, followed by 45–55 years (32.65%) and 25–35 years (22.44%). In small farms, the majority of farmers (32.25%) were concentrated in the 25–35 years age group, followed by 35–45 years (22.58%).

At the overall level, the highest proportion of farmers belonged to the 35–45 years age group (30%), followed by 25–35 years and 45–55 years categories, each accounting for 26.25 per cent of the total sample. Farmers above 65

years constituted only 5 per cent of the sample, indicating relatively lower participation of elderly farmers in off-season cabbage cultivation.

The predominance of middle-aged farmers suggests the presence of an economically productive and active farming population in the study area. Farmers belonging to these age groups are generally more capable of managing labour-intensive vegetable cultivation and adapting to changing production and market conditions.

Table 6: Age Distribution of Sample Off-Season Cabbage Farmers

Sl. No.	Age Group (years)	Marginal Farms	Small Farms	Overall
1	25–35	11 (22.44)	10 (32.25)	21 (26.25)
2	35–45	17 (34.69)	7 (22.58)	24 (30.00)
3	45–55	16 (32.65)	5 (16.12)	21 (26.25)
4	55–65	4 (8.16)	6 (19.34)	10 (12.50)
5	Above 65	1 (2.04)	3 (9.67)	4 (5.00)
6	Total	49 (100)	31 (100)	80 (100)

Note: Figures in parentheses indicate percentage to the respective total.

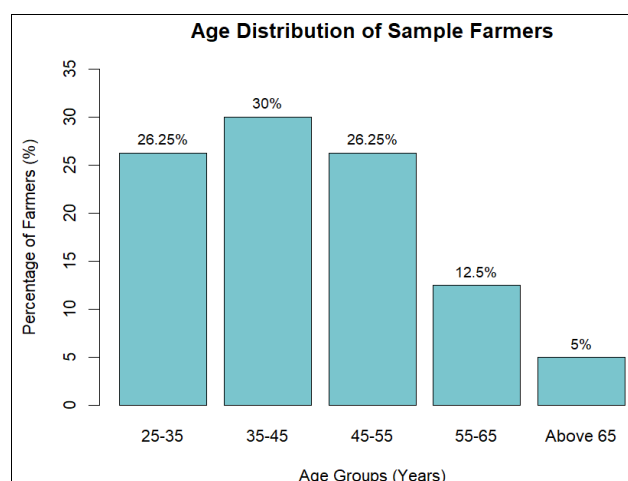


Fig 3: Age Distribution of Sample Off-Season Cabbage Farmers

Figure 3 illustrated the age distribution of sampled off-season cabbage farmers. The majority of respondents belonged to the economically active middle-age groups of 35–45 years (30.00%) and 25–35 years (26.25%), followed by the 45–55 years category (26.25%). The relatively lower proportion of older farmers indicates moderate participation of younger and middle-aged individuals in off-season vegetable cultivation. The predominance of economically active age groups may positively influence labour availability, managerial efficiency, and adoption of improved cultivation practices.

3.2.4 Educational Status of Off-Season Cabbage Growers

Education plays a crucial role in improving farm management efficiency, adoption of scientific cultivation practices, and access to market and institutional information. In vegetable cultivation systems, educational attainment influences farmers' ability to adopt improved technologies and respond effectively to changing production environments. The educational status of sampled off-season cabbage farmers is presented in Table 6.

Table 7: Educational Status of Sample Off-Season Cabbage Farmers

Sl. No.	Level of Education	Marginal Farms	Small Farms	Overall
1	Illiterate	17 (34.69)	5 (16.12)	22 (27.50)
2	Primary School	16 (32.65)	8 (25.80)	24 (30.00)
3	Middle School	10 (20.40)	6 (19.35)	16 (20.00)
4	Secondary	4 (8.16)	7 (22.58)	11 (13.75)
5	Higher Secondary	1 (2.04)	3 (9.67)	4 (5.00)
6	Graduate and Above	1 (2.04)	2 (6.45)	3 (3.75)
7	Total	49 (100)	31 (100)	80 (100)
8	Literacy Rate (%)	65.30	83.87	72.50

Note: Figures in parentheses indicate percentage to the respective total.

The results revealed moderate literacy levels among sampled farm households. At the overall level, primary school education accounted for the highest proportion of farmers (30%), followed by illiterate farmers (27.50%) and middle school education (20%). Farmers with secondary education constituted 13.75 per cent of the sample, while only a small proportion had higher secondary education (5%) and graduate-level education (3.75%).

Marginal farms exhibited relatively higher illiteracy levels (34.69%) compared to small farms (16.12%). In contrast, the proportion of farmers with secondary and higher education was relatively greater among small farms. The literacy rate was estimated at 72.50 per cent at the overall level, with small farms recording a comparatively higher literacy rate (83.87%) than marginal farms (65.30%).

The findings indicate that although basic literacy levels are reasonably satisfactory, higher educational attainment among farmers remains limited. Lower levels of formal education may restrict access to advanced production technologies, scientific crop management practices, and market-related information in off-season vegetable cultivation.

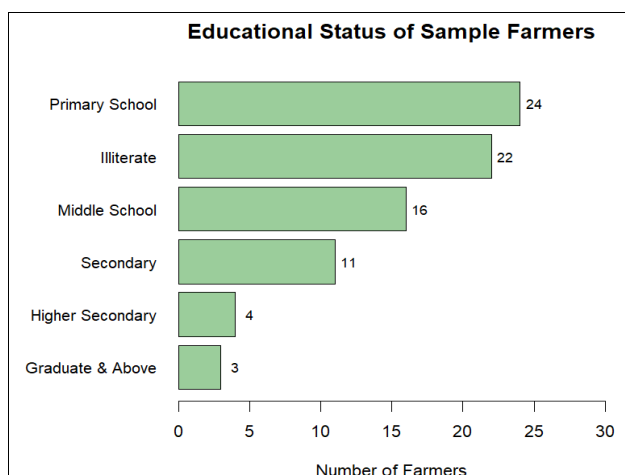
**Fig 4:** Educational Status of Sample Off-Season Cabbage Farmers

Figure 2 illustrated the educational status of sampled off-season cabbage farmers. The results indicated that the majority of respondents possessed primary and middle school education, while a considerable proportion remained illiterate. Only a limited number of farmers attained higher secondary and graduate-level education. The findings suggest moderate literacy among farm households; however,

lower higher-education attainment may restrict access to advanced production technologies, market information, and scientific farm management practices.

3.2.5 Land Usage Pattern of Off-Season Cabbage Farms

Land is one of the most important productive resources in agriculture and plays a significant role in determining farm income, resource allocation, and production potential. The pattern of land ownership and operational holding influences the scale and intensity of vegetable cultivation. The land usage pattern of sampled off-season cabbage farms is presented in Table 7.

The results revealed that the entire operational holding of sampled farms consisted of owned land, while no leased-in land was observed among either marginal or small farms. Marginal farms possessed 35.08 ha of owned land, whereas small farms accounted for 37.15 ha. The total operational holding across all sampled farms was estimated at 72.23 ha. The absence of leased-in land indicates that off-season cabbage cultivation in the study area is predominantly carried out on self-owned holdings. This reflects relatively stable land ownership patterns among sampled households and suggests limited dependence on tenancy arrangements for vegetable cultivation.

Table 8: Land Usage Pattern of Off-Season Cabbage Sample Farms

Particulars	Marginal Farms	Small Farms	Overall
Owned land	35.08 (100)	37.15 (100)	72.23 (100)
Leased-in land	0	0	0
Total operational holding	35.08 (100)	37.15 (100)	72.23 (100)

Note: Figures in parentheses indicate percentage to the respective total.

3.2.6 Dependency Ratio of Sample Farm Households

The dependency ratio of sampled off-season cabbage-growing households was estimated at 82.52, indicating that every 100 working-age adults supported nearly 83 dependent members. The relatively high dependency burden reflects considerable demographic pressure on economically active household members. In smallholder vegetable production systems, higher dependency levels may increase pressure on household income and labour allocation while reducing savings and investment capacity. The findings suggest that off-season cabbage cultivation serves as an important livelihood-supporting enterprise for sustaining household consumption and employment requirements under resource-constrained farming conditions.

Table 9: Dependency Ratio of Sample Farm Households

Particular	Value
Total children population	269
Total adult population	326
Dependency ratio	82.52

The findings further suggest that family labour plays an important role in sustaining off-season cabbage cultivation under smallholder conditions. Households with larger dependent populations may rely more heavily on labour-intensive crop enterprises to ensure stable income and household food security. The observed dependency burden

also highlights the importance of improving farm productivity, income diversification, and livelihood support mechanisms for enhancing the economic resilience of farm households in the study area.

3.2.7 Labour Participation Pattern in Off-Season Cabbage Cultivation

Table 9: Gender-wise Labour Participation in Sample Farms

Particulars	Number of Workers	Percentage (%)
Male labour	245	53.37
Female labour	214	46.62
Total labour	459	100

Labour participation plays an important role in labour-intensive vegetable cultivation systems such as off-season cabbage farming. The gender-wise distribution of labour participation in sampled farms is presented in Table 4.7. The results revealed that male labour accounted for 53.37 per cent of the total workforce, while female labour contributed 46.62 per cent. The relatively high participation of female labour indicates the significant role played by women in various farm operations associated with off-season cabbage cultivation. Female workers are actively involved in activities such as nursery management, transplanting, weeding, harvesting, grading, and post-harvest handling.

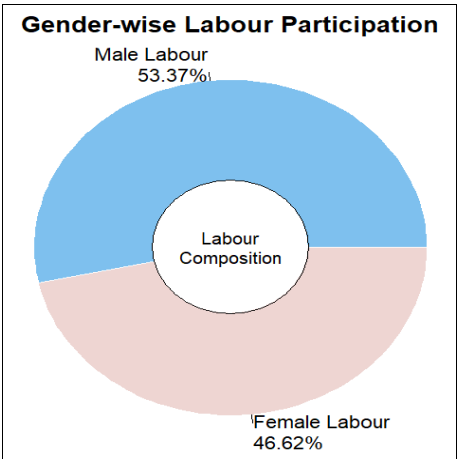


Fig 5: Gender-wise Labour Participation in Off-Season Cabbage Cultivation

Figure 5 presented the gender-wise composition of labour participation in off-season cabbage cultivation. Male labour constituted 53.37 per cent of the total workforce, while female labour accounted for 46.62 per cent, indicating substantial involvement of women in vegetable farming operations. The findings emphasize the labour-intensive nature of off-season cabbage cultivation and highlight the significant contribution of female labour in sustaining farm activities. The findings suggest that off-season cabbage cultivation largely depends on family-based labour systems, where both male and female members contribute substantially to farm operations. The considerable involvement of women highlights the importance of recognizing gender contributions in vegetable production systems and the need for policies aimed at improving women’s access to training,

extension services, and income-generating opportunities within the agricultural sector.

3.2.8 Workforce Composition of Sample Farm Households

Table 10: Workforce Composition of Sample Farm Households

Particulars	Number	Percentage (%)
Children population	269	45.21
Adult population	326	54.79
Total family population	595	100

The workforce composition of farm households provides important insights into the availability of economically active labour within smallholder farming systems. Table 10 presents the distribution of dependent and working-age population among sampled off-season cabbage-growing households. The results revealed that adult members constituted 54.79 per cent of the total household population, while children accounted for 45.21 per cent. The relatively higher proportion of working-age members indicates the availability of family labour for labour-intensive agricultural operations associated with off-season cabbage cultivation. However, the substantial share of dependent population also reflects demographic pressure on household income and resource allocation. The findings suggest that family-based labour systems continue to dominate off-season vegetable cultivation in the study area. Higher household dependency combined with limited landholding size may increase economic vulnerability and compel farm households to intensify labour utilization and diversify livelihood activities to sustain income and consumption requirements.

Discussion

Hill horticultural systems of Himachal Pradesh, where cabbage and other cole crops are predominantly cultivated in specific altitudinal zones with suitable temperature and moisture regimes. Off-season vegetable production is largely confined to ecologically suitable pockets rather than being uniformly distributed across regions (Rahi & Choudhary, 2017) [13]. The study observed fluctuations in productivity of cabbage across years and similar variability has been reported in low and mid hill regions of Himachal Pradesh, where cabbage yield is influenced by seasonal variation, hybrid performance, and management practices under rainfed conditions (Thakur, 2014) [14]. The study showed cabbage growers are mostly middle-aged, indicating active working-age participation in farming activities. Similar findings have been reported in vegetable-growing households in Maharashtra, where the majority of farmers belonged to the economically active age group, suggesting that vegetable cultivation is primarily managed by working-age farmers who can handle labour-intensive operations (Sindhura *et al.*, 2022) [15]. Findings show that medium to large family size supports cabbage cultivation due to labour requirements. Similar socio-economic studies in Indian vegetable systems show that medium family size households dominate horticultural production because family labour reduces dependence on hired labour in labour-intensive crops like cabbage. (Balaji & Selvakumar, 2024)

[16].

Conclusion

Off-season cabbage cultivation in the hill region of Manipur is an important livelihood activity dominated by marginal and small farmers. The study shows a positive expansion in area and production over time, indicating increasing commercialization of vegetable farming in the region. However, productivity remains moderately variable due to input, climatic, and market-related constraints. Strengthening institutional support, improving access to quality inputs, and developing efficient marketing channels are essential for enhancing productivity and farm income. The findings underscore the importance of promoting off-season vegetable cultivation as a viable strategy for rural livelihood diversification in hill agriculture systems.

Limitations

The study is limited to selected blocks of Senapati district and may not fully represent all hill districts of Manipur. The analysis is based primarily on cross-sectional primary data, which may not capture long-term dynamic changes in farming systems. Additionally, the study focuses on descriptive and trend analysis without incorporating advanced econometric modeling, which may limit deeper causal interpretation.

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