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RESEARCH ARTICLE

DETERMINANTS OF PRODUCTIVITY AND PROBLEMS ASSOCIATED WITH BETEL LEAF CULTIVATION IN SYLHET REGION OF BANGLADESH

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ABSTRACT

The study aimed at evaluating the determinants of productivity of betel leaf cultivation among the farmers of two districts namely Sylhet and Moulvibazar administered under Sylhet division, Bangladesh. A total of 80 respondents were selected as the sample using multistage random sampling technique for achieving objectives of the study. Data were collected through a structured questionnaire during the month of March, 2020. Based on the objective's descriptive statistics, ANCOVA and stepwise regression model were employed to analyze the data. The study found that, most of the farmers of betel leaf were followed their indigenous knowledge and technology to cultivate betel leaf. ANCOVA and stepwise regression model were employed to identify the factors as well as their impact on betel leaf production. The study identified the factors that significantly influenced the productivity of betel leaf farming i.e. the involvement of marketing agreement, access to training, access to irrigation, amount of cow dung applied and land area under betel leaf cultivation. The study also confronted some problems associated with the betel leaf cultivation like excess rainfall during peak season, insufficiency of irrigation water, disease attacks and low price of betel leaf. Therefore, this study provide essential information that can be used by the growers, scientists, exporters, policy makers to increase the productivity of betel leaf cultivation in the future. This study will build a foundation for further research based on the present background.

Keywords: Betel leaf, agronomic practice, productivity, determinants, Sylhet division

INTRODUCTION

Betel leaf (*Piper betle* L.), a member of the Piperaceae family is widespread and mainly grown in South East Asian nations for its lovely glossy heart-shaped leaves, which are chewed or consumed as betel quid (Biswas *et al.* 2022). It is originated from South and South East Asia and widely popular in Asian countries like Bangladesh, India, Indonesia, Malaysia, Thailand, Myanmer, Laos, Combodia, Vietnam, Nepal, Philippines, Sri Lanka and Papua New Guinea (Bajpai *et al.* 2010; Sudjaroen, 2012). In Bangladesh, its local name is 'paan' which is produced almost everywhere in Bangladesh (Rahman *et al.* 2009) and also is commonly used in social and ceremonial functions (Haque *et al.* 2018) while having important medical and nutritional benefits (Gupta *et al.* 2023). It facilitates digestion and eliminates mouth odor with increased dietary and nutritional value in the form of fiber, vitamins, and

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minerals (Biswas *et al.* 2022). Its leaf contains higher beneficial bioactive compounds which has a variety of important pharmacological effects especially antibacterial, antidiabetic, antiulcer, anti-inflammatory, anticancer, antimutagenic, and antioxidant qualities (Basit *et al.* 2023; Gupta *et al.* 2023). Thus, it is crucial to improve its production and quality in worldwide.

Bangladesh's economy is mostly dependent on agricultural output. In order to achieve the overall growth rate of the nation's economy, the growth rate of agriculture is a crucial prerequisite (Bhuiyan *et al.* 2021; Hossain *et al.* 2017; Sarkar *et al.* 2021). The area under cultivation and production of betel leaf in Bangladesh are growing with time. The entire area under cultivation of betel leaf in Bangladesh is around 21850 hectares with an estimated yearly production of 206994 MT with an average yield of 3836 kg per acre (BBS, 2023). Regarding this, after fulfilling the national demand as a cash crop, Bangladesh can export betel leaves to foreign countries with a strong export potential (Roy *et al.* 2019). It is a significant employer and source of cash in our nation. The cultivation of betel leaves is directly tied to the survival of a big portion of our community, particularly the hilly track people (Haider *et al.* 2013). Therefore, cultivation of betel leaves which have many medical benefits is a good source of income for our nation's struggling farmers.

Geographically, Bangladesh is divided into two different regions: a large deltaic plain and a small hilly region. And it is renowned for its fertile soil, which includes the Ganges delta, the Sylhet Division, and the Chittagong Hill Tracts. The places in Bangladesh where it is grown include Sylhet, Moulvibazar, Jessore, Khulna, Kustia, Bagerhat, Satkhira, Bhola, Barisal, Faridpur, Rajshahi, Rangpur, Gaibanda, Pabna, Cox's Bazar, and Chittagong district. In the Sylhet region, in particular, the total area under betel leaf cultivation was 113361 acres and the total production was 70050 MT with the yield of 655 kg per hectares (BBS, 2021). In Sylhet, since the early 1950s, when the Sylhet Forest division settled them as forest villagers, the Khasia ethnic minority has been using their traditional betel leaf agroforestry method in the north-eastern hill forests of Bangladesh (Nath and Inoue, 2009; Zakaria and Majumder, 2019). Khasia's production of betel leaves boosts income, which improves the socioeconomic standing of village households while mainly supply for the domestic use (Rahman *et al.* 2009; Zakaria and Majumder, 2019). Due to its high production profitability, farmers are keen to grow this perennial crop, which has the potential to become once more a significant commodity for generating foreign exchange. Therefore, Sylhet, as a promising area of betel leaf cultivation, is an important area to grow widely for boost up the national economy.

Productivity of a crop depends on the agro-morphological features (Atikunnaher *et al.* 2017; Islam *et al.* 2022; Sarker *et al.* 2022) and the genetic variability traits of that particular crop varieties (Sajid *et al.* 2022; Tabassum *et al.* 2023; Yesmin *et al.* 2022), resulting the fluctuation of yield potentiality. Bangladesh has produced a few varieties of betel leaves such as Chaltagota, Mahanali, Mithapaan and Sanchipaan along with some strains including Nati-bantoo, Ujani, Magi, Nangla, Jhal, and Gach paan (Mridha, 2002). Mostly in the hilly regions of greater Sylhet, the Khasia variety, also known as gach paan, is the widely cultivated variety. In the Sylhet Forest, at least 13 different Piper species are present, but only the *Piper betel* yielded betel leaves (Rahman *et al.* 2009). Due to the slightly acidic nature of the Sylhet region, several crop cultivars have reported the fluctuated yield potentiality (Monshi *et al.* 2015; Paul *et al.* 2021; Tabassum *et al.* 2015), however, betel leaf plants are grown well in sandy-loam and clay soil with moderate to slightly acidic conditions (Rahma *et al.* 2015; Verma *et al.* 2004). In the meantime, a deterministic, stochastic, and dynamic time series model has also been reported to illustrate the factors influencing the productivity of betel leaf cultivation (Mahfuza *et al.* 2020). Identifying productivity measurement of betel leaf cultivation along with agronomic practices which are facing existing constrains is crucial for improvement of this crop. However, data and information regarding betel leaf production and the status of local and international marketing system are scarce in the country. A very few studies were undertaken to evaluate the impact of influencing factors on the productivity of betel leaf cultivation. Therefore, the present study was undertaken to identify the significant determinants on the productivity of betel leaf cultivation in Sylhet region, Bangladesh along with assessing the existing agronomic management practices. This study specially aimed to do in depth analysis of identifying the factors and its impact on the productivity of betel leaf cultivation in the study area.

MATERIALS AND METHODS

Selection of the study area

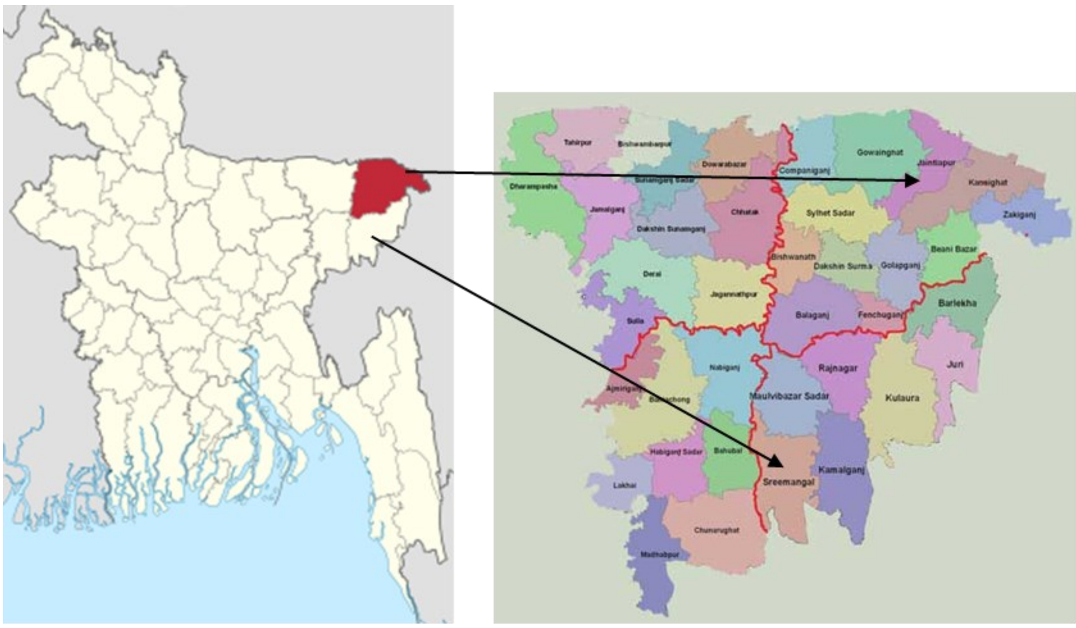
The Sylhet region was purposefully chosen for this study because it offers the potential for betel leaf cultivation. Keeping in view the objectives of the study as well as resource constraints, this research was considered the selected areas of Sylhet region where betel leaf cultivation were present. Khasihati and Mukampunji from Jaintapur upazila of Sylhet district as well as Longliachara punji and Niharpunji from Sreemangal upazila of Moulvibazar district were randomly selected within the Sylhet region (Figure 1).

Sampling technique

The list of farmers who were cultivated betel leaf was collected from the respective Upazila Agriculture office, Department of Agriculture Extension (DAE). Betel leaf farmers are mainly khasia farmer and they are limited in number. For this reason, a reasonable size of sample respondents was chosen in such a way that the information from it can meet up the purpose of the study. A total of 80 farmers were selected from the two districts by applying multistage random sampling technique for the study (Table 1).

Method of data collection

The primary data were collected during the month of March, 2020 using the questionnaire finalized by pretesting from the betel leaf growers through a field survey by face- to-face interview method. The researchers also assure them all the information would be kept confidential. After completion of each interview, the interview schedule was checked to be sure that the information supplied by the



(a) (b)

Figure 1: Map of study area: (a) Bangladesh map showing Sylhet division, (b) Jaintapur upazila under Sylhet and Sreemangal upazila under Moulvibazar district

respondents to each of the items had been properly recorded.

Summarization, tabulation and analysis of the data

After making necessary editing and checking, Normality, and equality of variance were tested to ensure data accuracy and to apply correct statistical techniques. Data were analyzed using the SPSS along with Microsoft Excel and R studio. Descriptive statistics like frequency, percentage, averages were used to describe the agronomic management practices while econometric models (ANCOVA and stepwise multiple regression) were applied to identify the determinants of productivity of betel leaf production.

Model specification

The appropriate econometric technique to deal with the continuous dependent variable and categorical and continuous independent variables was the ANCOVA model. Therefore, for the present study, depending on the nature of variables, Analysis of Covariance (ANCOVA) model was used for analyzing the admixture data (i.e., qualitative and quantitative variables) (Gujrati, 1970). And finally, stepwise multiple regression was conducted for including all of the predictor variables those have statistically significant relation with the response variable to build a regression model.

Analysis of Co variance (ANCOVA)

The ANCOVA method belongs to a larger family of models called GLM (Generalized Linear Models) that blends the linear regression and Analysis of Variance (ANOVA). In the present analysis, ANCOVA regression model was used for evaluating the factors affecting productivity of betel leaf cultivation, can explicitly be expressed as:

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_{12} X_{12} + \epsilon_i$$

Where,
Y_i= Average betel leaf production/acre;
β_0 =intercept; β_i= coefficients of the explanatory variables; X_i= explanatory variables; ε_i= error term.

Here, X_1, X_2, …, X_{12} respectively denotes sex of the farmer, level of education, involvement of marketing agreement, access to training, access to irrigation, problem in accessing inputs, experience, distance to market, total land cultivated under betel leaf cultivation, amount of cow dung and oil cake applied, amount of human labor. Assumptions of the selected model also tested.

Table 1: Table-1: Distribution of sampled respondents in the study area

Division	District	Upazila	Punji	No. of farmers
Sylhet	Sylhet	Jaintapur	Khasihati	17
			Mukampunji	23
	Moulvibazar	Sreemangal	Longliachara punji	20
			Nihar punji	20
Total Sample Size				80

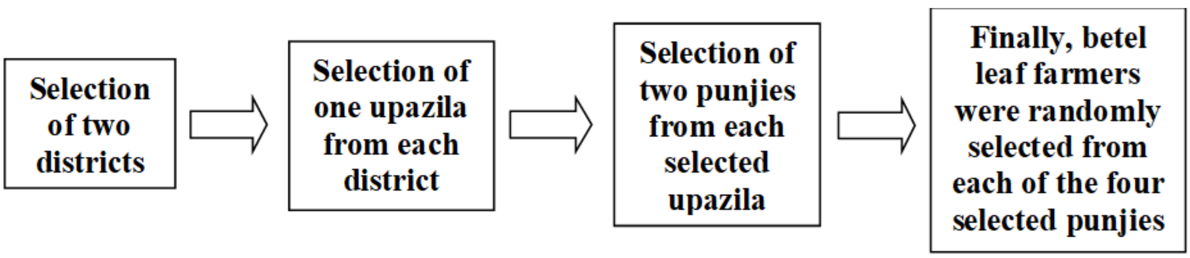


Figure 2: Multistage random sampling technique for the selection of the respective respondents

The secondary data were collected from different published journals, books, articles, newspapers as well as Bangladesh Bureau of Statistics (BBS) and Food and Agriculture Organization (FAO).

RESULTS AND DISCUSSION

1. Determinants of productivity of betel leaf cultivation

In the present study, ANCOVA model was used to evaluate the impacts of variables on the productivity of betel leaf farming. Here, dependent variable for ANCOVA is yield per acre of betel leaf and independent variables presented in Table 2. With regard to a continuous dependent variable, analysis of covariance is used to examine the main and interaction effects of categorical variables (P-value of 0.001), the relationship between productivity and farmed area was showed highly significant in betel leaf cultivation. The present findings are corroborated with the results of Mahfuza *et al.* (2020).

The Table-3 shows that the determinants i.e., Involvement of marketing agreement, Access to training, Access to irrigation, Quantity of cow dung had the significant impact on the productivity of betel leaf cultivation. Marketing agreement with market intermediaries was measured by the availability of contractual agreements based on pre agreed price. Result presented in the Table 3 showed that when other variables were controlled for, marketing agreement had significant effect on the productivity of betel leaf. The value of coefficient was -288.9 suggesting that farmers sold betel leaf to the market intermediaries, productivity would decrease by 288.9 unit per acre than those who directly sold to the market. This could be due to the lower price offered by the middleman. The primary source of income comes from the sale of betel leaf with high market price (Nath and Inoue, 2009).

The purpose of the training facility is to introduce farmers to new and improved agricultural inputs and better methods of improving productivity in turn increase marketable supply. The result showed that, when other variables were controlled for, access to training facility had significant and positively effect on the productivity of betel leaf. The value of coefficient was 297.3 suggesting that, when there have access to training facility, the productivity would increase by 297.3 unit per acre than those did not have access. High training facilities with appropriate education boost up the profitability of betel leaf cultivation (Hölzle, 2023; Sabur *et al.* 2022; Zakaria and Majumder, 2019).

Having access to irrigation helps to continue the production and hence increase

Table 2: Description of the independent variables used in the productivity model

Variables	Coding system	Category
X_1= Sex of the farmer	1 if male,0 if female	Dummy
X_2 = Farming experience	Number of years	Continuous
X_3= Education level of the farmer	If, 1= no education, 2=primary, 3=secondary, 4= higher secondary, and 5= above higher secondary	Categorical
X_4= Involvement of marketing agreement	1 if yes, otherwise 0	Dummy
X_5= Distance to the market	Number of kilometers	Continuous
X_6=Land under betel leaf cultivation	Number of acres	Continuous
X_7= Quantity of cow dung	Number of kilograms	Continuous
X_8= Quantity of oilcake	Number of kilograms	Continuous
X_9= Access to training	1 if yes, otherwise 0	Dummy
X_{10}= Access to irrigation	1 if yes, otherwise 0	Dummy
X_{11}= Problem in accessing inputs	1 if yes, otherwise 0	Dummy
X_{12}= Human labor	Man –days	Continuous

productivity at farm level. The result shows that when other variables were controlled for access to irrigation facility had significant and positively effect on the productivity of betel leaf. The value of coefficient was 381.895 suggesting that, when there had access to irrigation, the quantity of betel leaf production would increase by 381.895 units per acre than those who did not have access. Irrigation facilities increase the betel leaf production with minimizing the pest and diseases (Rahman *et al.* 2015; Ullah *et al.* 2022).

It is observed from the Table 3 that the quantity of cow dung had significant and positive impact on the productivity of betel leaf. The value of coefficient 0.107 indicates that when the application of cow dung is increased, the betel leaf production would be higher by 0.107 ton per acre. Al Zabir *et al.* (2019) stated that application of 2.55 t/ha of cow dung in betel leaf field yielded the higher production.

The value Adjusted R^2 value 0.66 indicates that about 66 percent of the observed variability in the productivity of betel leaf is explained by the explanatory variables which were included in the model. Figure 3 and 4 revealed that the residuals were normally distributed approximately. The normal curve should roughly correspond to the shape of the histogram and Q-Q plots. Therefore, the assumption of normality was fulfilled and the error variance of the dependent variable is found equal across groups which also hold the assumption of equality of variance of ANCOVA in Levene's test for Equality / homogeneity of Variances.

Stepwise multiple regressions were conducted by including all of the predictor variables which have significant influence on the productivity of betel leaf to build a final regression model. From the Table 4, it can be seen that the value of Adjusted R^2 is 0.67 indicates that about 67 percent of the observed variability in the productivity of betel leaf is explained by the explanatory variables which were included in the model. By applying a stepwise regression model, the adjusted R^2 increased by 0.01 percent, indicating that this was the best model for the data. In this final regression model using Stepwise multiple regressions analysis showed that the land area under betel leaf

Table 3: Parameter estimation of determinants of productivity of betel leaf cultivation

Source	Coefficients	Std. errors	t-value	Pr (>|t|)
(Intercept)	1605.97341	780.24217	2.058	0.043574 *
(Sex)2	-148.94142	78.60265	-1.895	0.062560.
(Education level)3	-36.46658	83.54092	-0.437	0.663912
(Education level)4	-20.56800	130.28591	-0.158	0.875050
(Education level)5	206.63289	149.58152	1.381	0.171884
(Involvement of marketing agreement)1	-288.89686	111.17630	-2.599	0.011571 *
(Access to training)1	297.26758	91.38391	3.253	0.001813 **
(Access to irrigation)1	381.89507	100.52288	3.799	0.000322 ***
(Problem in Accessing Inputs)1	-149.94062	130.99322	-1.145	0.256554
Farming experience	0.99341	3.02244	0.329	0.743456
Market distance	4.98790	5.84976	0.853	0.396975
Land under betel leaf cultivation	41.38682	27.01761	1.532	0.130413
Amount of Cow dung	0.10685	0.04558	2.344	0.022138 *
Amount of Oil Cake	-1.96999	2.89355	-0.681	0.498404
Human labor	-1.90330	2.58564	-0.736	0.464315
Residual standard error	284.2 on 65 degrees of freedom			
Multiple R-squared	0.7194			
Adjusted R-squared	0.659			

Significant codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Table 4: Stepwise regression results of determinants of productivity of betel leaf cultivation

Source	Coefficients	Std.error	t-value	Pr (>|t|)
(Intercept)	883.34303	114.91238	7.687	0.00009 ***
(Sex)2	-117.70346	74.96518	-1.570	0.120774
(Involvement of Marketing agreement)1	-280.99858	106.49563	-2.639	0.010197 *
(Access to training)1	261.47007	85.79604	3.048	0.003225 **
(Access to irrigation)1	402.65152	90.60881	4.444	0.021157 ***
Land under betel leaf cultivation	51.84953	24.98884	2.075	0.041570 *
Amount of Cow dung	0.14530	0.03668	3.962	0.000173 ***
Amount of Oil Cake	-4.09579	2.58283	-1.586	0.117174
Residual standard error	281.4 on 72 degrees of freedom			
Multiple R-squared	0.6952			
Adjusted R-squared	0.6656			

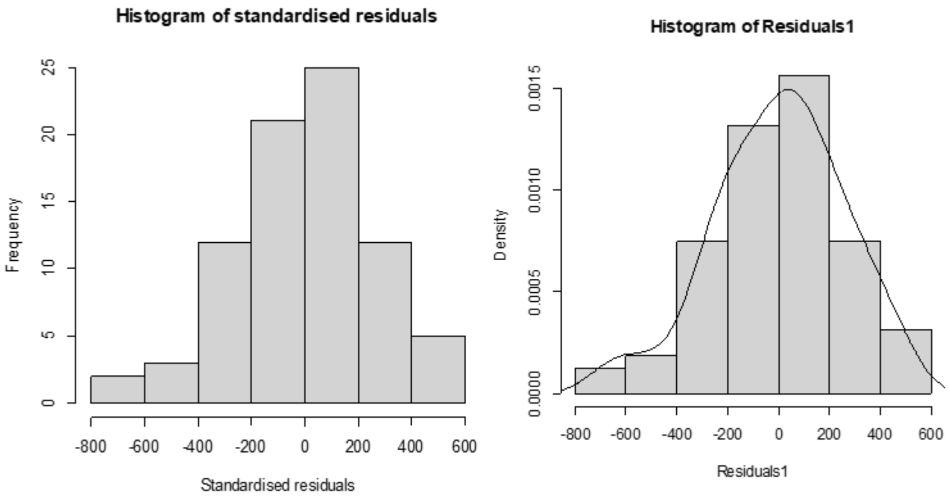


Figure 3: : Histogram of residuals against frequency of betel leaf productivity

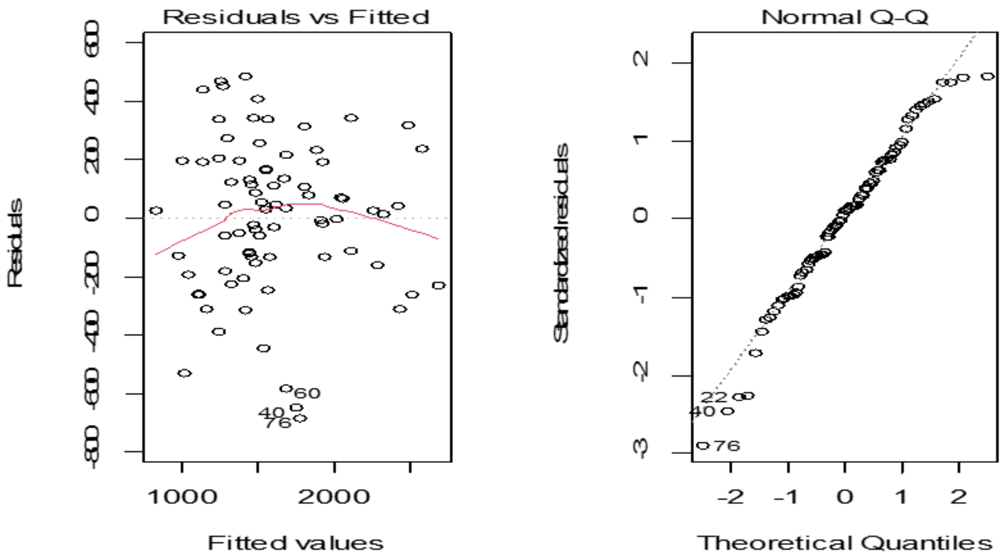


Figure 4: Normal Q-Q plot of residuals against fitted values of betel leaf productivity

cultivation also has a significant and positive impact on the productivity of betel leaf. The present findings are corroborated with the findings of Al Zabir *et al.* (2019) and Mahfuza *et al.* (2020).

2. Agronomic management system of betel leaf cultivation

There are two types of betel vine based on topography, namely plain land betel leaf and hilly betel leaf. Hilly betel leaf is known as 'gach paan' cultivated by the Khasia people using a different cultivation technique in greater Sylhet region. The most of the farmers of betel leaf are Khasia people and they use indigenous knowledge and technology to cultivate betel leaf presented in Table 5.

2.1 First operation cost including preparation of planting material

Betel leaf cultivation is a specialized type of agriculture and since the betel plant is a creeper, it needs a compatible tree or a long pole for support. When the production of betel leaf reduces significantly, they plant new cuttings near the base of old one so as to derive regular production of betel leaf (Hölzle, 2023; Sabur *et al.* 2022). Planting materials are generally collected from the old betel leaf plant. Generally, cuttings with four nodes were taken as propagules of the crop and usually the cutting was selected from a disease-free healthy vine that are three years or older. For seedling preparation 2, 4 or 6 branched cuttings were used. 2 branched cuttings were used most extensively, while 4-6 branch cuttings were used for planting depending on the girth of supporting trees (Table 5). The production of betel leaves within the farmers' field is stable under the dominant traditional management system (Nath and Inoue, 2009).

2.2 Seedling (betel vine) plantation and maintenance

During the commencement of the rainy season in May-August the betel vine planting is carried out. At a distance of about 12.5 cm from the supporting tree, they prepared planting pits with depth of about 15-20 cm for plantation of the betel vine. Seedlings were then placed in the dug holes. Two nodes of the cuttings of betel creeper were placed usually underground and a node kept above. For large supporting trees, 2 or 3 sides of the trees were planted with 6 branch cuttings. Farmers reported that, June and July are the best time for betel leaf plantation. Due to the tremendous profitability of betel leaf growing, the farmers are now highly motivated, and a sizable portion of them are involved (Mahfuza *et al.* 2020).

The cuttings do not require any maintenance until their new shoots emerge. It usually takes 10-15 days to emerge new shoots. For this period seedlings were kept free from weeds and grasses, so that new shoots were not suppressed. Proper shade and irrigation were maintained for the successful cultivation of this crop while ground was weeded about 2-3 times annually. Several positive sustainability indicators including disease control, soil fertility management, profitability, socio-cultural acceptability and institutional support increase the betel leaf productivity (Nath and Inoue, 2009; Ullah *et al.* 2020).

2.3 Manure or fertilizer application

Usually, betel leaf farmers use cow dung as organic fertilizer at the rate of 2-3 kg per support tree. Occasionally they apply oilcake powder mixed with cow dung in betel leaf plantation. Most of the farmers usually avoid chemical fertilizer so as to keep the soil nutrients intact. Since betel leaf cultivation requires high soil moisture, frequent light irrigation is necessary depending upon the season. Irrigation should be need-based and proper drainage is also essential during rainy season. Farmers provided irrigation, generally 7-10 day's interval in the dry season (November-March). It was bit expensive, but helps keeping production of betel leaf during dry season. The use of adaptation techniques like fertilizer uses and soil treatment, which are common in betel leaf cultivation, greatly mitigates the negative effects of climate change on crop productivity (Das and Bhattacharji, 2023; Juma and Haque, 2021).

2.4 Diseases

It was reported by the betel leaf growers in the study area that betel leaf plants have been infected by two diseases. Namely leaf rot and root rot. Gradually all of the leaves turn into a yellowish color and vine dies within two days. Haider *et al.* (2013) noticed the two major diseases name leaf spot and root rot those are harmful to betel leaf cultivation. These diseases are highly infectious, and within a week the entire garden is infected and dies. Generally, they uproot the infected vine and bury it far away. Leaf rot is locally known as utram. Spots develop on the leaves of the plant in the early stages. Gradually the infected leaves start to dry and finally the whole vine is attacked and dies. To prevent the disease from spreading, the farmers uproot all infected vines, and keep the field fallow for up to next 1 -2 years.

Table 5: Summary of Agronomic practices used in betel leaf cultivations in the study area

Types of land (%)	
High land	50%
Medium high land	28.75%
Plain land	21.25%
Types of soil (%)	
Sandy soil	0%
Drained loamy soil	75%
Sandy loamy soil	25%
Month of plantation (%)	
May	17%
June	50%
July	20%
August	13%
Planting material (%)	
2 branched cuttings	68.75%
4 branched cuttings	31.25%
6 branched cuttings	25%
Distance of pit from support tree (cm)	12.5 cm
Deepness of pit (cm)	15-20 cm
Hight of support tree (meter)	4-5 m
Weeding (Number of times/ year)	2-3
Pruning (Number of times/year)	1
Mulching (Number of times/ year)	2-3
Application of cow dung (Number of times/year)	3-4
Irrigation (Number of times/ year)	9
Application of pesticide (Number of times/year)	1-2
Disease attack	Leaf rot and Root rot disease

2.5 Harvest operation

Plucking of betel leaf is started in the second year and continued for about 10 years (Figure 5). Harvesting is carried out mostly in the month of June, July and August. Due to enough rainfall received during these months, the highest production of betel leaf was recorded with compared to other months when no management strategies are carried out. Plucking of betel leaves was done manually (hand picking) or by using simple instruments such as a knife. A single plant was usually harvested about five to six times a month even during the off seasons, November to May. A skilled worker could pluck a minimum of about 2280 leaves a day. When leaves of betel were on emergent trees, the Khasia people were able to make their harvest possible by using their local made ladder. Rahman *et al.* (2015) and Sabur *et al.* (2022) stated that the growing trend of higher labor costs led to an increase in the operation cost of betel leaf cultivation.

2.6 Processing of betel leaf

Freshly plucked leaves were stored in a basket made out of bamboo. The harvested leaves were spread on to a polythene sheet or across banana leave (Figure 6). Farmers in the study area reported that, a bundle contains 144 leaves and is locally called 'kanta' and bundle contains 288 leaves locally known as 'mora'. Betel leaves are sold in a unit known as a 'kuri', which consists of 2880 leaves (20 kanta). Female members of the Khasia family usually involve in the processing activities of betel leaf. Middlemen were found to play a significant role in betel leaf marketing process and unfortunately the benefits of high market prices went to the middlemen instead of the betel leaf farmers (Mahfuza *et al.* 2023; Zakaria and Majumder, 2019). Sometimes the farmers also directly sold the betel leaves to the market.

3. Constraints and problems associated with betel leaf cultivation

3.1 Lack of quality planting materials and adequate capital with high price of labor

About 81.25% farmers had mentioned about the problem of non-availability of quality seedlings (vine) (Table 6). Due to lack of sufficient reliable sources of quality planting materials, they could only use seeds and seedlings as planting materials that they collected from last year self-stock or from the neighbors. They also did not know about the newly released varieties of betel leaf. Adequate capital is the important element for running any business or crop production. The financial support is necessary for purchasing inputs for betel leaf cultivation. About 78.75% betel leaf growers reported that they had financial constraints (Table 6). Betel leaf is highly labor- intensive crop and family labor is not always sufficient for nurturing betel vines. Labor scarcity and high labor cost at the peak period of production and harvesting were some of the major problems for betel leaf production. About 77.50% t betel leaf growers faced this problem. Due to this high cost, a negative effect on its production appears unavoidable (Roy *et al.* 2019; Das and Bhattacharji, 2023).

3.2 Inadequate extension services with institutional credit and scientific knowledge of farming

In the study area, 41.25% farmers complained that they had not got any extension services regarding the new technology should be applied for betel leaf production from the Department of Agricultural extension (DAE) (Table 6). Institutional credit facilities were very limited in the study area. Farmers had to face many terms and conditions in getting

Figure 5: Betel leaf plant of different years

Figure 6: Processing of betel leaf

credits for their uses. In the study area, 85% of betel leaf growers reported that, they had lack of institutional credit facilities (Table 6). All the betel leaf farmers belong to khasia community depend on indigenous knowledge and technology to cultivate betel leaf in their home gardens. About 51.25% farmers had no scientific knowledge and technology regarding planting pattern, spacing, species selection for host plant and protection from insects and pests Mridha (2002) and Verma *et al.* (2004) demonstrated that betel leaf productivity hampered seriously due to the application of improper management practices at incorrect time and hence farmers who are engaged in betel leaf cultivation should be well skilled persons while being well trained.

3.3 Problem of storage and low price of betel leaf during peak harvesting periods

Lack of storage facilities for betel leaf production was another problem and it was noticed that all betel leaf growers in the study area did not have storage facilities for betel leaf. Huge quantities of betel leaf are grown and harvested during rainy season and also sold at lower prices due to lack of proper storage facilities.. About 76.25% betel leaf growing farmers reported that price of betel leaf was low during peak harvesting period (Table 6) while prices of betel leaf fluctuate from season to season. Low price of betel leaf due to the early spoiling of leaf was another major problem stated by Haider *et al.* (2013) and Rahman *et al.* (2009).

3.4 Problem of insufficient irrigation, heavy rainfall, pest and diseases

About 82.50 % farmers complained that insufficient supply of irrigation water was one of the major constraints in the study Area (Table 6). Irrigation is essential for betel leaf cultivation during dry season and it is bit costly. All the respondent farmers mentioned that excess rainfall during rainy season was another main problem that reduces the output. The respondent farmers also reported that excess rainfall occurred during peak season of harvesting and it will be favourable to spread the leaf rot diseases in betel cultivation resulting a drastical yield reduction. Diseases are major threat to betel leaf cultivation. As betel leaf is so susceptible to these changes which hampered the total production of betel leaf (Das and Bhattacharji, 2023; Masud *et al.* 2020).

3.5 Lack of transport and market facilities

Many farmers (87.5%) were not able to bring the production to the market at correct time due to lack of transportation facilities (Table

Table 6: Constraints faced by the betel leaf growers

Nature of the problem	Betel leaf farmers (n=80)	
	Frequency	Percentage
Lack of good planting material	65	81.25
Lack of adequate capital	63	78.75
High price of labor	62	77.50
Inadequate extension services	33	41.25
Lack of institutional credit	68	85.00
Lack of scientific knowledge of farming	41	51.25
Problem of storage	80	100.00
Low price of betel leaf during peak season	61	76.25
Problems of insufficient irrigation water	66	82.50
Heavy rainfall during peak season	80	100.00
Pest and diseases	80	100.00
Poor communication and lack of sufficient market information	70	87.50
Lack of market facilities	60	75.00
Problem in accessing inputs	-	78.80

6). This problem can be minimized through providing a good transportation system. Lack of market facilities was another problem for the farmers. Marketing of output in due time is essential. A strong syndicate of middlemen and wholesalers is prevailed in the marketing process, restricting the access of betel leaf farmers to the wholesaler market. About 75.0% farmers claimed that they had lack of market facilities (Table 6). Without providing a proper transportation and marketing system, betel leaf production will never be profitable (Hölzle, 2023; Juma and Haque, 2021).

3.6 Problem in accessing inputs

As markets are located far away from the punjis, households faced difficulties when purchasing inputs. About 78.80% farmers reported that they had problems in accessing inputs due to high price, shortage of supply, unavailability of inputs and long distance to the market (Table 6).

Finally, it can be concluded that farmers in the study area faced a lot of problems in producing betel leaf. The major problem that the respondent farmers mentioned, were excess rainfall during peak season, insufficiency of irrigation water, disease attack, storage problem, lack of good planting material, lack of sufficient market information and lack of institutional credit facilities. These farmers are still involved in farming despite taking on dangers including disease, climate change, and price swings (Al Zabir *et al.* 2019; Haider *et al.* 2013; Masud *et al.* 2020).

CONCLUSION

In the present study, due to the insufficient capital and technical management support, betel leaf farming is facing several problems and limitations, which cause lower earnings. Besides betel leaf cultivation they are now engaging on some other professions also. Their cultivation practices are also environmental friendly. If improved management practices, market access, access to training, supply of adequate capital and inputs especially access to irrigation and quantity of cow dung can be made available to farmers in time, helps the farmer to produce more betel leaf in efficient manner. Thus, the increase of yield and production of betel leaf would subsequently increase the total return of betel leaf farmers. From the results of the present study, it can be concluded that considerable scope exists in the study area to increase the productivity and employment of the farmers. In addition, betel leaf farming is a very labor-intensive industry that employs a large number of people in its production, packaging, shipping, and sales while generating enormous profits from both domestic and international trade.

AUTHOR CONTRIBUTION

RHU performed the experiments, analyzed and interpreted data. MSJM and MA conceptualized and designed the study MHM, MA and MHM performed the statistical analysis and drafted the manuscript.

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