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Research Article

Viability of Black Pepper (*Piper nigrum*) Farming in Sylhet District of Bangladesh

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ABSTRACT

The black pepper (*Piper nigrum*) plant is a well-liked spice plant with significant commercial value and great antioxidant potential. To investigate the native production techniques followed and assess the scope of black pepper gardening, information was gathered through personal interviews with 50 randomly chosen respondents directly and indirectly related to black pepper farming from the Gowainghat upazila in Sylhet district between July 2018 to December 2020. The majority of farmers preferred their own source of seedlings (80%), stem cutting (58%), ≤ 1 year of seedling (52%), July to August planting time (36%), planting density 2 to 3 per supporting plant (52%), 30×30×30 cm^3 pit size (42%). In response to intercultural operation, the majority of farmers avoid the use of fertilizer and manure (54.29%), watering (54%), fencing (96%), weeding (92%), pruning (94%), and pesticide (96%). Meanwhile, a high response was found for integrated production systems (100%), existing trees as support (84%), and pest infestation (78%). Flowering and fruiting information revealed that it took 3-4 years for the first flowering after transplanting (52%), May to June flowering month (78%), January to February harvesting time (68%) following manual harvesting method (100%), and maximum yield obtained was 3kg per plant (40%). Every single respondent (100%) employed the conventional way of processing. All of the respondents (100%) acknowledged the beneficiary and positive environmental impact of black pepper, whereas 76% were satisfied with their generated outcomes as they believed it could provide medicinal value (94%), and no health hazards (100%). It could be remarked that black pepper might be aided by a homestead and could contribute as a climate-smart agroforestry crop for local farmers of the Sylhet district in Bangladesh. Hence, policy implications regarding improved production techniques and standard marketing channels should be enforced. Further research on the improvement of black pepper gardening should be conducted.

Introduction

One of the oldest spices known to humankind is black pepper, also known as the "King of Spices" (*Piper nigrum* L.), belonging to the Piperaceae family (Sivaraman et al., 1999). One of the most traded spices in the world is black pepper, which is a native to South and Southeast Asia (Talucder et al., 2020). At present, it is primarily grown in China, India, Brazil, Indonesia, Malaysia, and Vietnam (Krishnamoorthy and Parthasarathy, 2010). The plant is mostly grown for its fruits, which are used all over the world as a spice, food flavoring, seasoning, and perfumery as well as a condiment (Philip et al., 1992). Due to its commercial and monetary significance in the worldwide spice market, it has been known around the world as the "king of spices" (Mustakim et al., 2022). For certain farmers in Bangladesh, particularly in Sylhet region, black pepper has been gaining a significant revenue crop. Black pepper can only be grown on around 5 ha of land in Sylhet, Habigonj, and Bogura district, and it only produces 6 metric tons of pepper every year (Talucder et al., 2020). Bangladesh imports more than thousands of tons of turmeric, cinnamon, black pepper, ginger, and cardamom. Black pepper is in high demand in the domestic market of Bangladesh. Only about 0.3 million hectares of the nation's estimated 16.7 million homesteads are occupied, a number that is steadily rising as the population rises (BBS, 2021). There are several options for growing black pepper in an agroforestry system. Additionally, the soil and environment of Sylhet region are excellent for the cultivation of black pepper. Trying to growing own vegetables in the backyard, employing black pepper, or building an agroforest help to better withstand the

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consequences of global warming. Organic black pepper cultivation improves the health and condition of the soil and results in high-quality, pesticide-free food (Sulok et al., 2018). Because the spice industry employs thousands of people as merchants, producers, exporters, and laborers, developing scientific procedures and processes to effectively market spices and allied items will benefit a country's economic prosperity. Unfortunately, several issues have caused our spice trade to diminish. Farmers are now growing black pepper, but their methods are outdated; in some cases, they haven't even recorded their methods, and they don't know where to sell their crops. Sulok et al. (2018) evaluated the role of natural farming as an ecological farming method to produce food that is grown organically is safe, and is of high quality while also improving the quality and health of the soil. Black pepper is grown using natural farming methods, which is thought to boost the number of beneficial microorganisms in the soil and may encourage the development and productivity of the crop. In addition to growing from seeds, black pepper may also be propagated vegetatively. However, since seeds have a short viability and a high level of sterility in the post-fertilization stages, seed propagation is laborious, uncertain, and only produces a small number of heterogeneous progeny (Ravindran, 2000). Additionally, plants made in this manner from various vines exhibit different growth patterns and outcomes (Philip et al., 1992). Therefore, in commercial cultivation, vegetative propagation is preferred. Although cuttings, grafting, layering, and budding can all be used to propagate black pepper, rooted cuttings are preferred for commercial cultivation (Sivaraman, 1987). A thorough examination of agronomical factors like the pre-production, production, and post-production activities is insufficient although different aspects of black pepper cultivation and production have been documented in various countries (Sivaraman et al., 1999). The utilization of household gardening based on black pepper to enhance rural subsistence in Bangladesh has received very little attention. There is a dearth of information on the impacts of contemporary production techniques on black pepper fields, notably in Sylhet. The potential of black pepper household gardening to improve rural Bangladeshi lives has received very little attention in the literature. These reasons led the researcher to choose to investigate the procedures applied in the Sylhet region's Gowainghat to produce pepper. This study would familiarise the researcher with the state of the pepper plantation and the problems impeding its expansion in Gowainghat. The objectives of this study were to gather information on the production techniques and marketing followed for growing black pepper in the Gowainghat upazila, and to look at its scope by determining opportunities, threats, strengths, and weaknesses. The study highlighted the marketing channel that should be refined in the Gowainghat upazila and assess black pepper gardening potential for improving the farmers' ability to support themselves. This may help policymakers become aware of the constraints and determine its potentiality in their respective garden.

Materials and Methods

Study Area

The Gowainghat upazila in Sylhet district served as the study's location which is located in Sylhet district, between 24°59' and 25°11' north latitudes and 92°03' and 92°14' east longitudes. The selected five unions are shown in Figure 1 with the Gowainghat upazila highlighted.

Population and Sample

Five unions—Fatehpur, Nandirgaon, Towakul, Rustampur, and Lengura—were randomly selected from the Gowainghat upazila in the Sylhet district. Farmers from these five unions made up the study's population. Ten respondents from each union who were either directly or indirectly involved in the farming of black pepper were selected at random as the study's sample. The sample size was 50.

Data collection techniques

Face-to-face interviews were conducted as part of this study. An organized interview schedule was created with the study's goals in mind to gather pertinent information. Information was gathered using the researcher's earlier-planned interview schedule. There were closed-ended, and open-ended questions on the agenda. The information was gathered using a variety of scales and the most straightforward queries. For the responders to understand and provide information in a consistent and organized manner, the questions were presented clearly and in a systematic order. Before the actual data gathering began, a pre-test survey was conducted. In light of the pre-test experience, the appropriate adjustments, additions, revisions, and rearrangements were made. Consequently, the interview schedule was made to be used at the conclusion. The survey included questions about the farmers' characteristics (age, education level, family size, homestead size, and annual family income), as well as their opinions on traditional black pepper gardening practices: the perspective of farmers about black pepper planting procedures, the flowering, fruiting information, processing, marketing, potential benefits, processing, marketing, and drawbacks. The researchers collected data for this study using in-person interviews between July 2018 to December 2020. Focus groups were held to confirm the facts.

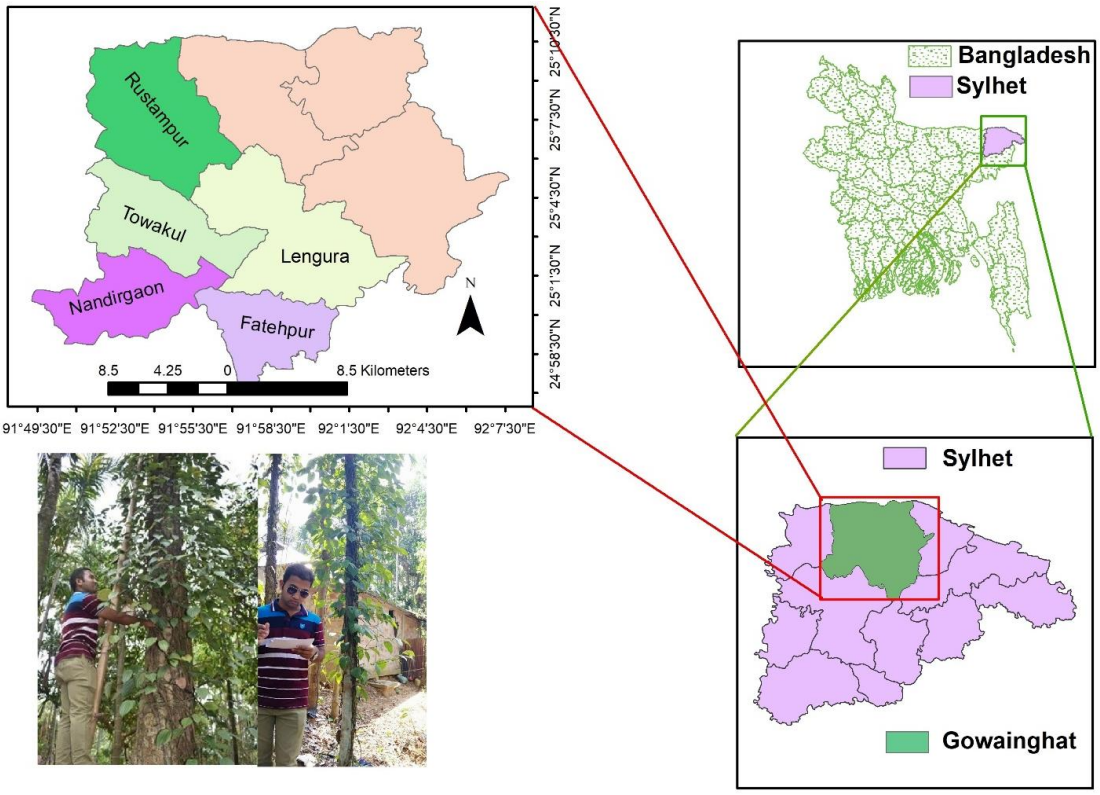

Figure 1. A Map of Sylhet district showing Gowainghat upazila

Statistical analysis

The objectives of the study were taken into account when analyzing the data that had been gathered. Where appropriate, a scoring method was used to convert qualitative data into quantitative data. The data were described using Microsoft Excel using frequency counts, averages, standard deviations, percentage distributions, and rankings.

Results and Discussion

Characteristics of the respondents

The respondents were aged between 24 and 75 years, with an average age of 50.54 and a standard deviation of 11.74. (Table 1). A similar age range was obtained for black pepper producers in Jaintiapur upazila (Kamrujjaman et al., 2023). The average educational level was 6.17±3.34. The majority of the interviewees had at least finished their basic school. The respondents' average family size was 4.29, with a standard deviation of 2.35 and a range of 3 to 11 members. The sample farmer's homestead size varied from 1.0 to 4.0 ha, with an average of 2.66±0.93 ha. The sample farmer's average monthly family income was Tk. 30.60±10.26 thousand, with a range of Tk. 11.0-55.0 thousand (Table 1). There were hardly any organizations for landless farmers in the study region. The black pepper sector was a secondary source of income for the majority of respondents. The farmers have access to a range of revenue streams, including agriculture, small companies, and services.

Table 1. Characteristics of the selected farmers at Gowainghat upazila

Features	Unit	Range of observation	Mean	SD(±)
Age	Years	24-75	50.54	11.74
Education level	Years	3-14	6.17	3.34
Size of family	No.	3-11	4.29	2.35
Size of homestead	Ha	1-4	2.66	0.93
Family income (all sources)	Tk. Thousand month^{-1}	11.0-55.0	30.60	10.26

The perspective of farmers on typical black pepper cultivation procedures

All farmers (100%) in the research area grew only native cultivars, most familiar black pepper variety "Jaintia black pepper-1" also known as "Jaintia golmorich." developed by the Bangladesh Agricultural Research Institute (BARI). In the Gowainghat upazila, over 80% (Table 2) of the farmers grew their seedlings, whereas

only 20% of farmers purchase black pepper seedlings from neighbors or other sources, such as the neighborhood nursery, bazaar, etc. The results of the survey made it clear that the majority of respondents (58 per cent) used stem cuttings to produce black pepper seedlings. Stems with a minimum of three nodes were removed from mother plants that developed vigorously and healthily for stem cutting which were used as planting materials after a certain period of time. Similar stem cutting was used by farmers in Jaintiapur upazila (Kamrujjaman et al., 2023). The transplantation process took 45 to 60 days. About 42 per cent of the respondents also mentioned using tactics called "Seedling from Seed". None of the interviewees mentioned using terminal shoots or rooted cuttings for black pepper cultivation on the working site. Stem cuttings were used in the research area because they were thought to be the simplest and most cost-effective way of vegetative growth (Mustakim et al., 2022). In Gowainghat upazila of Sylhet district, 52% of farmers claimed to have planted seedlings that were only a year old or younger. Contrarily, 36% of farmers stated that they had seedlings which were at least a year old and up to two years old when they had been planted. Almost 12% of farmers used seedlings that were older than 2 years. The majority of farmers (36%) thought black pepper seedlings were sown in July and August, while only 32% thought that it was done in May and June. Due to inadequate precipitation and soil moisture, none of the farmers could consider November to February to be the planting season. From December to February, farmers refrained from planting owing to a lack of precipitation and soil moisture (Kamrujjaman et al., 2023).

About 52 per cent of farmers in Gowainghat upazila reported using two to three seedlings per supporting plant, 36 per cent said they only used one seedling, and just 12 per cent indicated they used more than three seedlings. About 42 per cent of respondents reported utilizing 30×30×30 cm^3 size pits, whereas 28 per cent reported using 45×45×45 cm^3 size pits. In their black pepper gardens, the majority of the farmers (54.29 per cent) didn't use either fertilizer or manure, while 42.86 per cent solely used manure and 2.86 per cent used both. The homesteads of their respective territories were efficient enough to sustain the species naturally (Ruba and Talucder, 2023). The intercropping of black pepper with leguminous reduction helps in better nutrient cycling (Trevisan et al., 2017).

While 46% of farmers opined that they had applied irrigation to the newly transplanted black pepper, more than half (54%) of farmers said they did not irrigate their black pepper garden. Only at very early stages of black pepper's establishment were watered in the study area as, irrigation could facilitate the growth of black pepper during the dry season (Parthasarathy et al., 2007). In contrast to the 96% of farmers in the black pepper plantation, just 4% of farmers in the Gowainghat upazila of the Sylhet district used fences. The study's findings show that while 16 per cent of respondents grew black pepper on the ground, roughly 84 per cent of respondents supported their cultivation using already-existing trees (Table 2). In the Sylhet district's Gowainghat upazila, supporting plants used to aid in the production of black pepper include Tal (*Borassus flabellifer*), Dewa (*Phaleria macrocarpa*), Betel nut (*Areca catechu*), Tamarind (*Tamarindus indica*), Date palm (*Phoenix dactylifera*), and Mander (*Erythrina variegata*).

Every farmer (100%) claimed that the homestead agroforestry system was used to grow black pepper there with already-existing trees. Because the yield of black pepper is enhanced with the use of supporting plants (Kumar et al., 2021). Only 8% of survey participants weeded the black pepper garden, compared to 92% who didn't and 94% who didn't practice pruning. It was noted that weeds are one of the primary obstacles in the production of black pepper (Ravindran, 2000), and farmers use growing cover crops to smother the weeds and mulch made of various organic elements (Lemessa and Wakjira, 2015) can act on weed management. Only 6% of respondents did not report any pest infestations, including insects, spider species, rotting diseases, etc. while 78% of respondents observed. On the other hand, 16% of respondents said they knew nothing about insect attacks. Only 4% of farmers claimed to have applied pesticides to black pepper plants as lower productivity might be evident due to sudden infestation (Devasahayam, 2000). Meanwhile, 96% did not apply any pesticides although black pepper could be prone to low production due to the high intensity of pests (Talucder et al., 2020).

Table 2. The perspective of farmers about typical black pepper planting procedures

Features	Possible perspective	Frequency	Per cent
Source	Self-production	40	80.00
	Neighbors/others	10	20.00
Propagation mode	Seedling from Seed	21	42.00
	Stem cuttings	29	58.00
	Terminal shoot	0	0.00

Features	Possible perspective	Frequency	Per cent
	Rooted cuttings	0	0.00
Age of seedlings	≤ 1 year	26	52.00
	1 year – 2 years	18	36.00
	> 2 years	6	12.00
Planting time	January- February	0	0.00
	March-April	10	20.00
	May- June	16	32.00
	July-August	18	36.00
	September- October	6	12.00
	November-December	0	0.00
Planting density per supporting plant	<2	18	36.00
	2-3	26	52.00
	>3	6	12.00
Pit size (cm^3)	30×30×30	21	42.00
	45×45×45	14	28.00
	65×65×65	11	22.00
	>65×>65×65	4	8.00
Use of fertilizer and manure	Only fertilizer	0	0.00
	Only manure	18	42.86
	Both fertilizer and manure	5	2.86
	Neither fertilizer nor manure (none)	27	54.29
Watering to newly transplanted black pepper garden	Yes	23	46.00
	No	27	54.00
Use of fence	Yes	2	4.00
	No	48	96.00
Supports used for Black pepper gardening	Existing trees	42	84.00
	Concrete pillar	0	0
	Ground	8	16.00
Production system	Sole	0	0.00
	Integrated	50	100.00
Weeding	Yes	4	8.00
	No	46	92.00
Pruning	Yes	3	6.00
	No	47	94.00
Pest infestation	Yes	39	78.00
	No	3	6.00
	Don't know	8	16.00
Pesticide use	Yes	2	4.00
	No	48	96.00

The perspective of farmers on typical black pepper flowering and fruiting

According to 52 per cent of farmers in the Gowainghat upazila in the Sylhet district, it takes 3-4 years for a black pepper plant to blossom after being planted, while just 40 per cent believe it takes less time (Table 3). About 78 per cent of farmers indicated that black pepper flowers were in May and June, whereas 16 percent of respondents claimed that black pepper flowers were in March and April (Table 3).

November through April was reported by 32% of respondents as the harvest season in the Gowainghat upazila, where 68 per cent of farmers said that the black pepper fruit was harvested in January and February, as opposed to only 18 per cent in March and April and 14 per cent in November and December (Table 3). They provided updates on the harvest season from November to April. Every farmer (100%) claimed to harvest black pepper by hand. A single-pole bamboo ladder serves as the harvesting support in this approach. Since multiple harvesting requires a manual process and is, therefore, more expensive, it was not used. Similar results were obtained for harvesting by farmers in the Jaintiapur upazila where a single-pole bamboo ladder was used to aid harvesting in this approach (Kamrujjaman et al., 2023) as cost-effectiveness was a paramount feature in the research area when harvesting was done by hand. Meanwhile, contemporary harvesting and processing methods (Dhas and Korikanthimath, 2003) were also reported for black pepper production. Black pepper yearly output was 2.9±1.0 kg sustaining $plant^{-1}$, (1 to 4 kilograms). Fruiting occurs every alternate year. Farmers claim that 4-5 kg of raw black pepper berries yields 1 kilogram of dry black pepper berry.

Table 3. Farmer's perception of flowering and fruiting of black pepper in Gowainghat upazila

Features	Possible perspective	Frequency	Per cent
First flowering time after transplanting (years)	<3	20	40.0
	3-4	26	52.0
	5-6	4	8.0
	>6	0	0.0
Flowering month	January- February	0	0.0
	March-April	8	16.0
	May- June	39	78.0
	July-August	3	6.0
	September- October	0	0.0
	November-December	0	0.0
Harvesting time	January- February	34	68.0
	March-April	9	18.0
	May- June	0	0.0
	July-August	0	0.0
	September- October	0	0.0
	November-December	7	14.0
Harvesting method	Manually	50	100.0
	Other	0	0.0
Yield (kg/plant)	1	6	12.0
	2	9	18.0
	3	20	40.0
	4	15	30.0

Figure 2. Process flow diagram for processing steps of black pepper (Dhas and Korikanthimath, 2003)

The perspective of farmers on typical black pepper processing, marketing, and value addition

Standard processing methods for black pepper are vital for ensuring clean and high-quality commodities. The typical processing followed in the study area differed from the standard processing method (Figure 2).

Figure 3, is a flowchart depicting the numerous unit processes that comprise the typical processing of black pepper. It was determined that the typical processing technique (Figure 3) utilized in the research area required improvement. In the research area, fully developed fruits were harvested to avoid overripening, severe losses from dropping, and bird and squirrel damage. Black pepper's ability to absorb moisture from the air might be the resultant in the growth of mold and insect infestations (Talucder et al., 2020). Farmers utilized polybags to facilitate better storage.

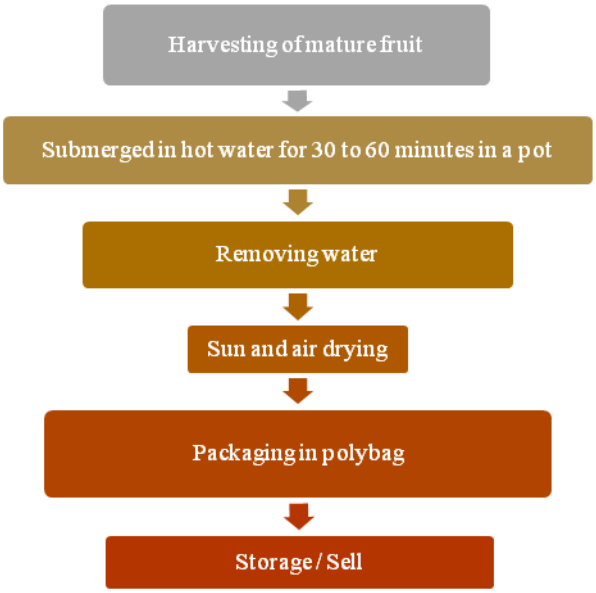

Figure 3. A flowchart showing steps of how farmers in Gowainghat upazila handle black pepper

Black pepper was reported to cost between Tk. 500 and 700 per kilogram, compared to Tk. 1220 and 1480 per kg at Sylhet's retail market (Kamrujjaman et al., 2023). Between a farmhouse and a super shop, there is a tremendous price difference. This may be because of inadequate transportation and communication systems frequently require small businesses to sell their goods through middlemen (Figure 4). Trading is advantageous for middlemen due to highly segmented markets and unequal bargaining power between buyers and suppliers.

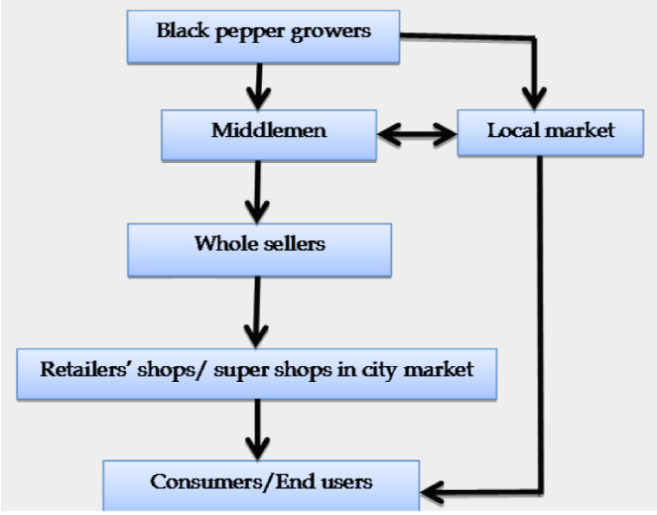

Figure 4. Flowchart of the marketing channel of black pepper at Gowainghat upazila

The respondents from Gowainghat upazila did not carry value-added black pepper fruit products such as dehydrated green pepper, canned green pepper, bottled green pepper, or white pepper.

The perspective of farmers on the potential benefits of black pepper on the environment

All (100%) of the respondents of Gowainghat upazila opined that there was a positive impact of black pepper production on the environment. They thought that the black pepper plant gave us oxygen and it helped the environment to keep sound (Table 4). At Gowainghat upazila in Sylhet district, 94% of growers knew black peppers' contribution in capturing CO_2 followed by soil improvement (92 per cent), increasing amenity (84 per cent), and releasing O_2 (82 per cent). The majority of farmers were aware of the therapeutic benefits of black pepper fruit (94 per cent). They asserted that black pepper fruits have therapeutic properties for treating a variety of ailments, including coughs, colds, indigestion, pain, and neurological disorders. None of the farmers (100%) who worked in the black pepper garden reported any health problems. Only 24% of farmers reported being dissatisfied with their black pepper crop, compared to 76% who were happy overall.

Table 4. Farmers' opinion regarding the environmental impact of black pepper gardening in Gowainghat upazila

Features	Possible perspective	Frequency	Per cent
Environmental impact	Positive	50	100
	Negative	0	0
Knowledge on Beneficial effect	Improve soil	46	92
	Increase amenity	42	84
	Release of O_2	41	82
	Capture of CO_2	47	94
Medicinal value	Yes	47	94
	No	3	6
Health hazard	Yes	0	0
	No	50	100
Level of satisfaction	Satisfied	38	76
	Not satisfied	12	24

The perspective of farmers on the drawbacks of a homestead-based black pepper business

Black pepper is one such business that might help with SDGs achievement. A survey and discussions with focus groups were used to conduct a SWOT analysis to determine the opportunities, threats, and strengths that the black pepper producers faced (Figure 5). Following the focus group discussion, the absence of high-quality planting materials and improved varieties was identified as a particular weakness. Once more, respondents indicated that major risks to the increase of black pepper production were insect infestation, inadequate marketing channels, and climate change. Black pepper's survivability in the study area is mostly dependent on the intercropping conditions. Poor farm management, the occurrence of diseases and pests, plant senescence, the failure to popularise elite cultivars as well as poorly maintained farms with traditionally available high-yielding cultivars, the depletion of soil fertility, damage to supporting plants as a result of pest attack, etc. are all factors that contribute to low productivity. Smallholders' scattered farming practices and a lack of long-term investments in agricultural reform pose two additional risks. It has been stated that the growing area for black pepper production has diminished because producers are ignorant of illnesses, insect assaults, and management techniques (Talucder et al., 2020).

According to farmers' viewpoints, it was discovered that there was a big market opportunity for the production of black pepper due to its advantages as a distinctive spice with high local demand. Another claim made was that black pepper needed just minimal maintenance and was best grown fast in conjunction with other agroforestry systems. They were able to identify the positive effects on the environment, such as high value, therapeutic value, and others. Black pepper processing was mostly done by women. Men predominated when it came to marketing. It opened up opportunities for income and women's empowerment. When it comes to climate-smart elements, facilitations, amenity enhancement, soil health improvement, functioning as a source of oxygen, and CO_2 sink were notable qualities suggesting that black pepper planting in the homestead area contributes to SDGs of poverty reduction, women empowerment, and climate action. Thus, the production of black pepper helps to achieve the SDGs' goals for food security, women empowerment, and climate resilience, either directly or indirectly.

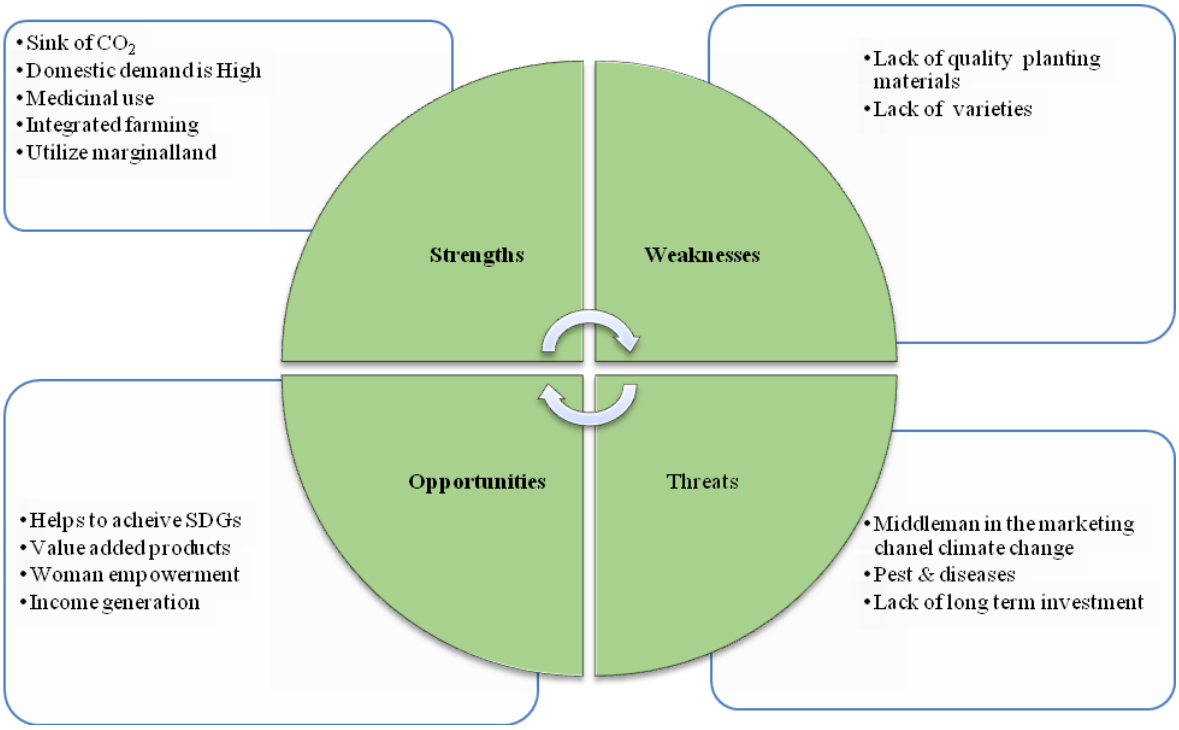

Figure 5. SWOT evaluation of the black pepper business

Farmers of black pepper in the Gowainghat upazila of the Sylhet district mentioned the following limitations (Table 5). The greatest barrier was determined to be a lack of superior planting materials, which was followed by a lack of effective methods for controlling pests and diseases, a lack of irrigation facilities and high-yielding cultivars during the dry season, etc. Lack of good planting material is one of the biggest issues facing black pepper farmers. However, standard management and processing techniques are necessary to produce high-quality pepper (Ravindran, 2000). Standard propagation methods have several flaws, such as a poor

success rate, insufficient roots, the transmission of soil-borne infections, and a low rate of transferred rooted cutting survival.

Table 5. Obstacles to growing black pepper in Gowainghat upazila of Sylhet district

List of constraints	No. of respondents	%	Rank
Lack of high-quality planting supplies.	49	98.00	1
Lack of proper management techniques for insects and diseases	47	94.00	2
lack of varieties with high yields	45	90.00	3
Lack of irrigation facilities	44	88.00	4
Lack of marketing of products	39	78.00	5
Lack of good agricultural management practices	35	70.00	6
Lack of training	32	64.00	7

In the research area, there were reports of a sizable price difference for black pepper between farmhouses and mega shops. The results show that merchants and middlemen benefit greatly from the marketing of black pepper. This was a result of the inadequate marketing systems already in place as well as the farmers' lack of information and market expertise. The small-scale nature, precarious financial situation, and dispersed distribution of the farmers present serious challenges for marketing the products indicating that marketing challenges are a major barrier to the growth of such businesses as black pepper farming (Ahmed et al., 2008; Bakht, 1984). Trading is advantageous for middlemen due to highly segmented markets and unequal bargaining power between buyers and suppliers. The remarks claim that black pepper production is significantly more profitable for merchants and middlemen. The farmers' lack of market skills and knowledge, as well as the shortcomings of the marketing framework, are the causes of this. Farmers have many marketing challenges because of their widespread distribution, shaky financial status, and small-scale enterprises. In addition, marketing challenges made it difficult for industries like black pepper cultivation to expand. Due to more fragmented marketplaces and unequal negotiating power between buyers and sellers, trading is more lucrative for middlemen than for original producers.

Conclusion

Due to favorable climatic and edaphic conditions, black pepper is one of the promising ingredients for potential homestead agroforestry systems in Bangladesh, context. There is a knowledge gap regarding appropriate planting techniques. Lack of understanding about planting techniques and operations such as irrigation systems, superior planting materials, and varieties were the biggest problems for the production of black pepper. Again, the post-harvesting activities are not satisfactory enough as processing technology and marketing infrastructure are not up to the mark. Such activities need special attention as the incomes of rural populations could be increased by introducing modern processing technology and strengthening marketing infrastructure. Farmers should be trained on modern production and processing techniques in place of outdated ones alongside strengthening the marketing system and middlemen's abuse minimization. For black pepper to be made profitable, there needs to be a certain marketing network between the producer and the customer. In the case of eliminating top constraints, farmers should have access to high-yielding cultivars and modern black pepper cultivation techniques after receiving training. The government must put quality pepper at the top of its list of priorities.

Conflict of interest

The authors declare no conflict of interest.

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