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MORALITY BEFORE KNOWLEDGE

Women's income generating activities and community disaster resilience: Evidence from Gaurichanna Union

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ABSTRACT

Background: In Bangladesh especially in rural regions, women empowered through income generating activities (IGAs) and can enhance their capacity to cope with different disaster. Rural women are involved in different works in agricultural and non-agricultural sectors. The main aims of this study are to identify the existing income-generating activities (IGAs) of women in the study area; and to examine the role of women's income-generating activities in community disaster resilience. **Methods:** The study was conducted at Gaurichanna Union in Barguna Upazila, Bangladesh. To conduct this research, data has been collected through individual questionnaire survey, focus group discussion, and life history from local people for fulfill the objectives. **Findings:** It has been found that the main income generating activities (IGAs) of the study area are, agricultural activities (homestead gardening, cattle and goat rearing, poultry rearing, worm composting, pond fish culture and fruit tree cultivation) and non-agricultural activities (tailoring, handicraft, rice/paddy husking, daily worker, street vendor and running small business). The results suggest that women's participation in these activities contributes to improved household income, livelihood diversification, and enhanced capacity to cope with economic and environmental shocks. **Conclusion:** The study highlights that IGAs can support household livelihood security and contributes to strengthening resilience in disaster-prone coastal communities. These findings provide useful insights for policymakers and development organizations seeking to promote women's economic participation and community resilience in vulnerable rural areas of Bangladesh. **Novelty/Originality of this article:** This study lies in linking rural women's income-generating activities with household disaster resilience in a coastal hazard-prone context. By linking women's economic participation with multiple dimensions of resilience, the research highlights the role of women's livelihood strategies can strengthen adaptive capacity in vulnerable rural communities.

KEYWORDS: coastal Bangladesh; community resilience; income-generating activities (IGAs); livelihood diversification; rural women.

1. Introduction

Income Generating Activity (IGA) refers to any activity that produces income for a family. Such activities may include agriculture, livestock rearing, fishing, post-harvest processing, and various services. Income-generating programs are economically focused and aim to increase the cash flow available to families, improve the local economy, and

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strengthen livelihood strategies to reduce vulnerability (ADB, 2007). IGAs can also be defined as initiatives that help women earn income through their own efforts (Alana, 1994; Dangol, 2010). These activities significantly improve the living conditions of poor people in terms of housing, nutrition, savings, clothing, healthcare, sanitation, education, and overall quality of life (Ullah & Routray, 2007). Women, like men, are an essential part of society and play a vital role in nation-building. Their contribution to the development process has been increasingly recognized across the world. However, women in almost all societies, both past and present, have not enjoyed the same status, rights, privileges, and powers as men (Dangol, 2010; Sheheli, 2012). Women who participate in income-related activities or contribute financially to their families tend to be more empowered than those who do not. Earning and contributing to family expenses enable women to exercise their rights and powers, which enhances their self-esteem and self-confidence (Sultana & Hossen, 2013; Islam, 2014).

In Bangladesh, women constitute nearly half of the total population. If properly mobilized and organized, they can serve as a great resource for national development (Parvin et al., 2005). Women's income plays a crucial role in achieving economic growth and sustainable development in the country. The economic empowerment of women is considered one of the key strategies for disaster recovery and reconstruction, as women play a vital role in enhancing household and community resilience (Sheheli, 2012). However, rural women in Bangladesh still have minimal or, in some cases, no access to development activities. Without their effective participation, it is impossible to ensure sustainable improvement in the livelihoods of rural communities (Rafiqul, 2011). In this context, Income Generating Activities (IGAs) play a crucial role in sustainable income generation and food security for rural women (ADB, 2007). Moreover, recent labor force surveys by the Bangladesh Bureau of Statistics indicate a rapid increase in women's participation in economic activities (Khatun et al., 2014).

Encouragingly, Bangladesh has introduced several measures to improve women's income status. These include quotas in government administration, public services, and local government, as well as initiatives to increase girls' school enrollment (Sheheli, 2012). Like other patriarchal societies, Bangladeshi women are often confined to their homes due to cultural, religious, and social restrictions. Nonetheless, rural women increasingly participate in various IGAs such as crop production, livestock and poultry rearing, aquaculture, and other profitable activities (ADB, 2007; Al-Amin, 2008; Hoque & Itohara, 2009). Women from the poorest households sometimes work outside the home as paid laborers for their families' survival (ADB, 2001), although their contributions often go unrecognized (ADB, 2004). Despite these efforts, most rural women have limited opportunities to participate in household, socio-economic, and political decision-making processes, and they have very little interaction outside their homes. These factors isolate women from development activities and restrict their access to income, knowledge, and skills-hindering their economic and social independence (Mayoux, 2000).

This study is based on the assumption that women's participation in income-generating activities (IGAs) can enhance household livelihood security and contribute to community disaster resilience. Although women's income-generating activities have been widely studied in relation to women's empowerment, poverty reduction, and livelihood improvement, their role in strengthening household and community disaster resilience in coastal Bangladesh remains relatively underexplored. The conceptual framework of this study describes the relationship between women's participation in income-generating activities (IGAs) and community disaster resilience. Women's involvement in various IGAs such as livestock rearing, poultry farming, crop cultivation, fisheries, and small businesses-contributes to livelihood diversification and income generation at the household level. Increased income and diversified livelihood options improve household livelihood assets, including financial resources, food security, savings, and practical skills. These improvements enhance the adaptive capacity of households by enabling them to better prepare for, cope with, and recover from disaster-related shocks such as cyclones, floods, and economic disruptions. Consequently, strengthened household adaptive capacity contributes to building overall community disaster resilience, particularly in disaster-prone coastal areas where livelihood stability plays a crucial role in reducing vulnerability. Women's participation in IGAs can help households cope with income shocks, ensure food security, and prevent vulnerable families from falling into poverty. Empowering women socially, culturally, politically, and economically can accelerate a country's overall development process. Therefore, women's engagement in IGAs is expected to contribute to strengthening household resilience and overall community disaster resilience. Women's involvement in various IGAs contributes to livelihood diversification and income generation at the household level. Increased income and diversified livelihood options improve household livelihood assets, including financial resources, food security, savings, and practical skills. These improvements enhance household adaptive capacity by enabling families to better prepare for, cope with, and recover from disaster-related shocks.

The coastal district of Barguna is one of the regions in Bangladesh that is highly vulnerable to natural disasters and socio-economic challenges. Rural households in coastal Bangladesh frequently experience cyclones, tidal surges, flooding, salinity intrusion, and other environmental shocks that negatively affect livelihoods, food security, and household income. These recurring hazards increase socio-economic vulnerability and reduce the adaptive capacity of poor rural communities. Despite the presence of various development initiatives, the rate of women's employment and participation in income-generating activities remains relatively low in many rural areas. Therefore, examining the role of women's livelihood activities in such contexts is important for understanding how local communities adapt to environmental and economic pressures. For this reason, the present study was conducted in Gaurichanna Union of Barguna District as an appropriate case for examining how women's livelihood activities contribute to household adaptive capacity and disaster resilience in a coastal hazard-prone context. This research aims to assess the current status of women's income-generating activities in the study area, with special attention to women's perceptions of how IGAs contribute to building community disaster resilience. Specifically, the study seeks to: to identify the existing income-generating activities (IGAs) of women in the study area; and to examine the role of women's income-generating activities in community disaster resilience.

2. Methods

2.1 Description of the study area

The study was conducted in Gaurichanna Union of Barguna Sadar Upazila in Barguna District, located in the south-western coastal region of Bangladesh (Fig. 1). Barguna district lies approximately 11 feet above mean sea level, which makes the area highly exposed to coastal hazards such as cyclones, storm surges, and flooding. The geographical location of the district is between 21°50′05″ to 23°04′11″ North latitude and 89°59′50″ to 91°04′08″ East longitude. According to Population and Housing Census (2011), Gaurichanna Union consists of twelve villages, namely Khajurtala, South Khajurtala, Betbunia, North Lakurtala, Baishtabak, Badarkhali, Kalaimudafat, Monshatali, Vutmara, Roadpara, East Dhupti, and West Dhupti. The local economy is mainly dependent on agriculture, fisheries, and small-scale livelihood activities. Several non-governmental organizations (NGOs) operate in the area and support rural livelihoods, including BRAC, Shongram, DORP, Grameen Bank, Proshika, ASHA, Caritas, and Uttaran. These organizations provide microcredit, livelihood training, and social development programs that encourage women's participation in income-generating activities.

2.2 Research design and sampling strategy

This study adopted a mixed-methods approach, combining quantitative and qualitative techniques to obtain a comprehensive understanding of women's income-generating activities and their contribution to community disaster resilience. A total of 100 households were selected for the questionnaire survey. A purposive sampling technique was applied to select respondents. Women who were actively engaged in income-generating activities (IGAs) such as livestock rearing, poultry farming, crop production, small business, fisheries, or other livelihood activities were considered eligible for participation in the study. The respondents were identified with the assistance of local community leaders, NGO workers, and union representatives, who helped locate women involved in such activities.

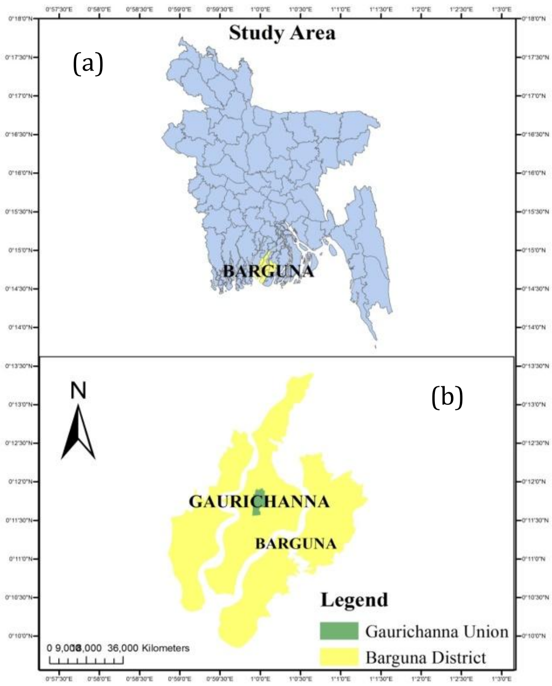

Fig. 1. Location map of the study area: (a) location of Barguna District in Bangladesh map; (b) location of Gaurichanna union in Barguna District

To ensure representation from different geographical locations within the union, respondents were distributed across the twelve villages of Gaurichanna Union. The village-wise distribution of the sample was as follows: Khajurtala (15), South Khajurtala (12), Betbunia (11), North Lakurtala (10), Baishtabak (10), Badarkhali (9), Kalaimudafat (7), Monshatali (7), Vutmara (6), Roadpara (5), East Dhupti (4), and West Dhupti (4). All respondents in the questionnaire survey were women. Since purposive sampling was used, the selected households were not intended to represent the entire population statistically. Rather, the sampling approach aimed to capture diverse experiences and contexts of women participating in IGAs within the study area. This limitation has been acknowledged in the study.

2.3 Data collection methods

2.3.1 Individual questionnaire survey and focus group discussions (FGDs)

Primary data were collected through a structured questionnaire survey conducted at the individual level. The questionnaire was designed to gather information on respondents' socio-economic characteristics, types of income-generating activities, level of participation in IGAs, household income contribution, and perceived benefits of IGAs in improving livelihood resilience. A total of 100 face-to-face interviews were conducted with women involved in income-generating activities across the twelve villages of the study area. The survey helped generate quantitative data on the distribution of different IGAs and their perceived impact on household economic conditions.

To complement the survey findings, five Focus Group Discussions (FGDs) were conducted with local women who were engaged in income-generating activities. Each FGD consisted of 8–10 participants selected from different villages to ensure diversity in livelihood activities and experiences. The FGDs focused on topics such as: Types of income-generating activities practiced by women, opportunities and challenges in participating in IGAs, contribution of IGAs to household income and food security, the role of IGAs in coping with natural disasters and economic shocks. FGDs provided deeper insights into the collective experiences and perceptions of women regarding livelihood improvement and resilience.

2.3.2 Key informant interviews (KII)

Seven Key Informant Interviews (KIIs) were conducted with individuals who have professional knowledge and practical experience related to women's livelihood activities in the study area. These informants were selected purposively based on their roles and expertise. The key informants included: Upazila Statistics Officer, a teacher, NGO representatives from BRAC, Shongram, DORP, and Grameen Bank, a member of the Union Parishad. These interviews helped provide institutional perspectives on women's participation in IGAs, local development initiatives, and community resilience strategies.

2.3.3 Respondents' Life History and secondary data collection

In addition to surveys and group discussions, two life-history interviews were conducted with selected respondents who had long experience in income-generating activities. The life histories were collected to understand changes in livelihood patterns, coping strategies during disasters, and the long-term impact of IGAs on household well-being. The discussions were recorded using a mobile phone and later transcribed. The narratives were carefully reviewed to identify key themes related to livelihood adaptation, economic empowerment, and resilience building. Furthermore, secondary information was collected from various sources including books, academic journals, government reports, NGO publications, and online databases. These materials were used to provide background information on women's livelihoods, income-generating activities, and disaster resilience in coastal Bangladesh.

2.4 Data analysis

Quantitative findings from the questionnaire survey were triangulated with qualitative insights from FGDs, KIIs, and life-history interviews. Survey data were used to identify the distribution and types of income-generating activities, while qualitative methods provided deeper understanding of women's experiences, coping strategies, and perceptions regarding livelihood security and resilience. The integration of multiple data sources helped validate the findings and strengthen the overall interpretation of the study. Quantitative data were coded and entered into Microsoft Excel 2010 and analyzed using descriptive statistical techniques including frequency distribution and percentage analysis. The coded variables included respondents' age, education level, occupation, type of income-generating activities, income contribution, and perceived livelihood benefits from IGAs. Descriptive statistical techniques such as frequency distribution and percentage analysis were used to summarize the data and present the results in tables and graphs. Qualitative data collected through FGDs, KIIs, and life-history interviews were transcribed and analyzed using thematic analysis. Key themes were identified regarding women's participation in IGAs, livelihood diversification, income stability, and coping strategies during natural hazards. The contribution of income-generating activities to community disaster resilience was assessed by examining how IGAs helped households to: diversify income sources, improve food security, increase savings capacity, and cope with environmental and economic shocks. The assessment of disaster resilience in this study was guided by a multidimensional resilience framework adapted from previous resilience literature. The framework considered physical, social, economic, institutional, and adaptive-capacity dimensions of resilience to examine how women's income-generating activities contribute to livelihood security and disaster coping capacity at the household level. Finally, findings from the survey data and qualitative interviews were triangulated to ensure consistency and strengthen the reliability of the results. The integration of quantitative and qualitative evidence allowed a deeper understanding of how women's income-generating activities contribute to household livelihood security and community resilience.

2.5 Limitations of the study amd ethical considerations

This study has several limitations that should be considered when interpreting the findings. First, the study applied a purposive sampling approach and selected 100 women who were actively engaged in income-generating activities in Gaurichanna Union of Barguna district due to self-funded research. As a result, the sample was not designed to statistically represent the entire population of rural women in the district or other coastal regions of Bangladesh. Therefore, the findings should be interpreted as context-specific insights rather than generalizable results for the wider population. Second, the study relied partly on self-reported information from respondents, which may include recall bias or subjective perceptions regarding income contribution and resilience. However, to minimize this limitation, the study used multiple data collection methods, including questionnaire surveys, focus group discussions, key informant interviews, and life history narratives. Third, the research was conducted within a limited time frame, which restricted the possibility of observing long-term changes in women's livelihoods and resilience capacity. Despite these limitations, the use of mixed methods and triangulation of quantitative and qualitative data helped to strengthen the reliability and depth of the findings. Future research may consider larger and more representative samples across multiple coastal districts to better understand the long-term impact of women's income-generating activities on household resilience and community disaster risk reduction.

Before conducting the interviews, the objectives of the study were clearly explained to all participants. Verbal informed consent was obtained from each respondent prior to data collection. Participation in the study was entirely voluntary, and respondents were informed that they could withdraw from the interview at any stage. The confidentiality and anonymity of participants were maintained throughout the research process, and the collected information was used solely for academic research purposes.

3. Results

3.1 Socio-economic condition of study area

The selected sample in this study comprises of 100 women who are involved in income generating activities (IGAs) in the study area. Table 1 shows age groups of the women participating in income generating activities (IGAs) as ranging from 15 years to 65 years old. The majority of respondents (43%) were aged between 26 and 35 years which are mostly involved in IGAs. About one third of respondents (30%) were aged between 36 and 45 years. While the rest only 20%, 7% of the respondents who were aged between 15-25, 46-65 years respectively. Education is an important factor for Income Generating Activities (IGAs) of women. Education is always valued as the means of liberation from ignorance and enables one to perform effectively the economic activities. The educational statuses of women are very poor. Maximum respondent's educational qualification is till primary level. The majority of the respondents (71%) who participated in informal economic activities had low level of education. Most of them did not finish the primary level. So they are not aware enough about their basic human rights. Table 1 shows the educational status of respondents. Among respondents 20% are illiterate, 71% finished primary level, and 4% finished secondary level and 5% adult educatio.

There is a significant positive effect of marital status on rural women involvement in non-agricultural income generating activities. Marital status has been used as an important factor that may influence women's participation in income generating activities. The marital status of participant is also shown in Table 1. About 77% of the respondents were married. There was only 8% divorced and only 11% respondents were widow. The rest of the respondents only 4% were separated. Here most of women have middle income range. Among respondents 10% families have income range of <4,000 taka per month, 30% families have income range between 4,000-7,000 taka per month, 45% families have income range between 7,000-10,000 taka per month and 15% families have income range, >10,000 taka per month which is shown in Table 1. Women are always concern about their income status.

Table 1. Socio-demographic information of the respondents. (frequency, N = 100)

Variable	Values	Percentage (%)
Gender of the respondents	Male	0
	Female	100
Age profile	15-25 years	20
	26-35 years	43
	36-45 years	30
	46-65 years	7
Educational status	Illiterate	20
	Primary Education	71
	Secondary Education	4
	Adult Education	5
Marital status	Married	77
	Divorced	8
	Widowed	11
	Separated	4
Personal income (Taka per month)	<4,000	10
	4,000-7,000	30
	7,000-10,000	45
	>10,000	15
Housing condition	Kaccha	42
	Semi-Pucca	45
	Pucca	3
	Jhupri	10
Savings	Savings	60
	No savings	40

Housing is an important component of physical capital and serves as a key indicator in determining the status of livelihood. The houses owned by rural women are constructed with various qualities of materials such as brick, tin, straw and soil depending on their economic capabilities. The interior decoration of houses also varied greatly along the socio-economic status of the rural family. There are different types of houses in the study area as follows kaccha, semi-pucca, pucca and jhupri type houses. Here 42% of respondent said that their houses are kaccha, 45% said that their houses are semi-pucca. Only 3% respondent's houses were pucca and 10% were jhupri which is mentioned on Table 1. Research findings from FGDs prove that the housing condition of rural women depended on their income group and farm size. Table 1 shows that about 60% of the participating women are found engaged in savings groups (for example, Grameen Bank, Brac Bank, Asha Bank, Heat Bangladesh, Shuktara Mohila Somity, Dorp etc). In this group, the participant women depending on their convenience save Taka 50 to 1,000 per month. Women save money at the same time, spend small amounts in the household. While the rest 40% women engaged in non-savings group.

3.2 Income generating activities (IGAs) practiced by women in the study area

3.2.1 Agriculture based income generating activities (IGAs)

The participation of women in income generation and domestic tasks are varied by region, religion, and class. In this study Income generating activities of women can be divided into two broad categories: agricultural and non-agricultural activities. Women in the study area engaged in several economic activities at a time. According to the Fig. 2 of agricultural based livelihood pattern of the study area shows that most of women income source is homestead gardening 95%, poultry rearing 90%, cattle and goat rearing 70%, pond fish culture 25%, worm composting 30% and fruit tree cultivation 38%.

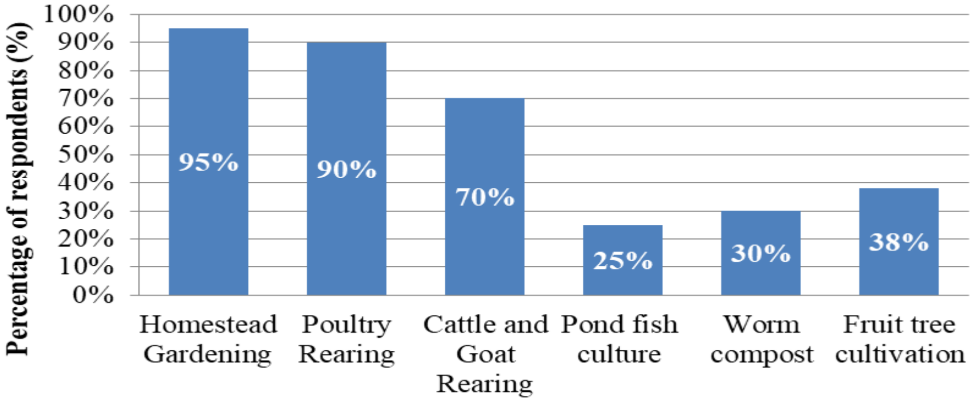

Fig. 2. Agricultural Based Livelihood pattern of the study area.

The average monthly income of respondents based on agricultural activities is Homestead gardening 500 Tk, Poultry rearing 1,000 Tk, Cattle and goat rearing 7,500 Tk, Pond fish culture and fish drying and making net 4,000 Tk, Worm composting 10,000 Tk and Fruit tree cultivation 8,000 Tk (Table 2). The Table 2 states that the average monthly income is high in worm compost and low is homestead gardening.

Table 2. Average monthly income of respondent.

Source of income	Average monthly income (Taka)
Homestead gardening	500 Tk
Poultry rearing	1,000 Tk
Cattle and goat rearing	7,500 Tk
Pond fish culture and fish drying and making net	4,000 Tk
Worm composting	10,000 Tk
Fruit tree cultivation	8,000 Tk

3.2.1.1 Homestead gardening

Homestead gardening is the main agricultural activity of women (95% respondent) in study area which provides the major share of livelihood resources for poor family. Homestead gardening can be described as a mixed cropping system that encompasses vegetables, fruits, plantation crops, species, herbs and medicinal plants as well as livestock that can serve as a supplementary source of food and income. In the study area, homestead gardening are a well-established land-use system where different vegetables and trees are grown, capital input is low, occupy a small area and simple techniques are applied and the family members themselves participate as labor. Primarily, homestead gardens are the source of supplementary food which plays an important role to meet nutrient requirements for a family. Vegetables from homestead are mostly consumed at home and only the surplus is sold. Homestead gardening improves the resources of poor women and also meets several socio-economic and ecological conditions which contribute to sustainability and better living.

3.2.1.2 Poultry rearing

Poultry rearing, which is mostly homestead- based, is one of the most important contributors to the agricultural sectors. In the study area women are unable to work outside their home or beyond their homestead because of family restrictions, social and traditional barriers. Given these difficult circumstances, homestead poultry rearing is considered is the best way to utilize the capabilities of women to be reproductive and add value to the household. Women (90% respondent) involved in home-based poultry rearing (e.g. hens, ducks, swans, geese, birds etc.) are a traditional practice for almost every rural family, as it generates extra income for families. It is an integral part of agro-rearing practices of the village community. Rural women have the opportunity to rear poultry in their homestead because it requires minimum land small amount of capital and uses traditional technology. Rural landless women are directly or indirectly involved in poultry rearing activities. Usually, the investment for starting this business is only cost of 15 to 20 eggs which about Tk. 150 to Tk. 200. These eggs are kept in a neighbor's house and the neighbor's hen is used to hatch baby chicks or baby ducks. Rural women take care of the chicks till they grow up. The chicken fed mainly on the husk from rice. After six months, these hens and ducks are able to produce eggs every day for at least six weeks. The male head of the family sells these eggs at the local market. Sometimes, shop-keepers buy eggs directly from the rural women who live nearby.

Through these traditional poultry rearing practices, rural women are empowered by being involved in decision making process of their households. The increased involvement in decision results in the improved status of women in relation to the husband and the family. They can spend money for themselves, which gives them independence to take part in making family decision. Greater financial independence for women increase their arguing capacity, reduces violence against women, and enables then to gain more influence over decision making in the family.

3.2.1.3 Cattle and goat rearing

Cattle and goat rearing is the basis of survival for poor and landless households in the study area. Who are involved in cattle and goat rearing among the respondents, those women received training from government veterinary hospital for cattle and goat rearing and have come to know about how can be benefited. They get fodder and grass seed from government veterinary hospital. Goat has been described as a poor people cow (or mini-cow) because of its immense contribution to the poor economy.

They not only supply nutritious and easily digest able milk to their children but also regular source of additional income for poor and landless women. Being small-seized animals, goat can easily be managed by women and children. Feeding, milking and care of goats do not require much equipment and hard work. Capital investment and feeding costs are also quite low. Goats can be successfully reared in study areas where fodder resources are limited and milch cattle do not thrive. In the study area, goat farming plays a vital role in providing gainful employment. The poorest women collect dung from fields for making dried dung cakes that they sell during the winter. One strategy for the very poor is taking animals on shared ownership, whereby poor women care for richer people's animals in return for 50% of its production including offspring. Cattle rearing are difficult for women-headed households due to the small number of working members. Goat and cow rearing (even on a shared-basis) requires collection of fodder or taking the animals regularly for grazing. Through these cattle and goat farming practices, rural women are being so much benefited and improved their family status.

3.2.1.4 Pond fish culture, fish drying and making net

The most common livelihood of Gaurichanna union of Barguna district is pond fish culture, fish drying and making net. In the study area, most of the respondents who are involved in fish cultivation received training from Danida prokolpo and to know the appropriate time and method for fish cultivation. Almost all homes have one or more ponds. Maximum women have mixed fish cultivation consisting of growing common Carp, Silver, Catla, Ruhi, Mrigel, Grass Carp, Tilapia and small indigenous fish cultivated together can quick profit as they are fast growing, tasty and have good market demand. The small indigenous fish have contains vitamin, mineral such as zinc and iron and very nutritious and can contribute to meeting the family's nutritional needs.

Most rural household rear livestock and poultry, the excreta of these animals used to increase productivity of the pond, without any negative effects and thus reduce the expenses in fish cultivation. From the survey information, most of the women among respondents engaged in seasonal fish drying at Gaurichanna union in Barguna district. Nishanbaria, Taltoli, Asar Char, and Pathorghata in Barguna district are the main places for seasonal fish drying, net making and they brings good profit. Many women and children are engaged in cleaning fish, spreading them on bamboo or wooden platforms to dry in the sun and packaging them. They preserve surplus production for household consumption and for marketing when the family needs more cash.

3.2.1.5 Worm composting

Based on survey data, the average monthly income high is worm composting (Fig. 3) among the respondents of study area. Women receive training from Songram local NGO to cultivate worm and have come to know about how can be benefited. Through this training and loan from Government, NGO with very low interest and they inspired to get started a worm composting.

Fig. 3. Worm composting

Worm composting is an easy and efficient way to recycle kitchen waste and small amount of garden waste into a fine, nutrient-rich compost and a concentrated liquid fertilizer for homestead garden. Worm composting is simple and inexpensive. It is very popular and profitable business for rural women in the study area. Starting a worm composting some points need to be considered: Kept in a shed or a sheltered area of the garden when it gets neither too cold in the winter nor too hot in the summer.

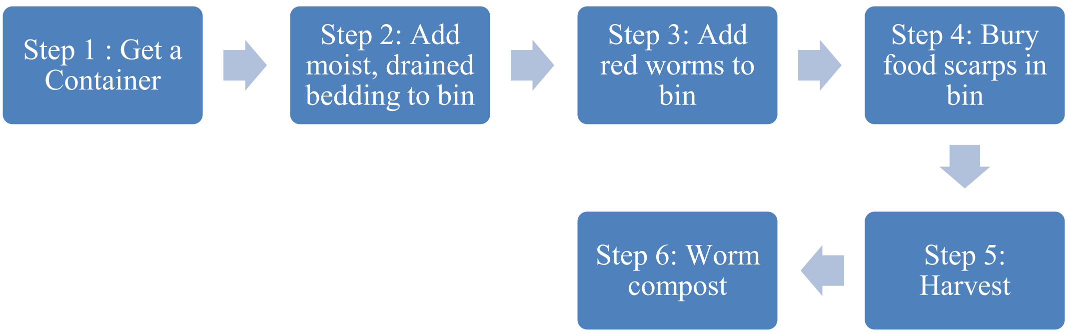

Fig. 4. Process of worm composting

Because they will not tolerate extreme acidity and dislike being waterloggedFive basic things need to get started a worm composting: 1. container, 2. bedding, 3. moisture, 4. worms and 5. kitchen scarps (Fig. 4). Worm composting is produced in a container filled with moistened bedding red worms. The bedding may consist of moistened shredded newspaper and leaves. Added to that is food waste from the household. Worm composting is a natural method for recycling nutrient-rich food scraps without any resulting odor. The worms go crazy over such an ideal living habitat, both eating and reproducing plentifully. The resulting compost, called worm castings, is an excellent soil conditioner for house plants, patio containers and gardens. Worm composting reduces the amount of household garbage that goes to the landfill. The compost can be used immediately, or store it and directly mixed with potting soil or garden soil as a soil amendment, which helps to make nutrients available to plants. Women have been successfully composting with worms over the past few years and so much benefited by selling worm compost. Women can generate income in a short period and can bring high profit with a little investment.

Table 3. Solid waste used for worm composting

Worms Love	Worms Hate
Vegetable scraps, Breads and grains, Fruit rinds and peels, Tea bags, Coffee grounds and filters, Crushed eggshells etc.	Meat or Fish, Butter, Greasy, Oily foods, Animal wastes etc.

There is case study 1 about worm composting, a successful Income Generating Activities for women. M, a 28-year-old woman, lives in Khajurtala village of Gaurichanna Union in Barguna Upazila. She studied up to grade five and has a family of four members, including her husband and two children. Her son is 13 years old and her daughter is 10; both are studying at a local school. Her husband once tried to run a restaurant business but was unsuccessful. After facing a huge loss, he had to close the business and is now working as a day laborer. Their family's financial situation became much worse than before, and they even had to sell some of their property to repay debts. Her husband's income was not enough to meet their daily needs. One day, a neighbor visited M's house and, after hearing about her struggles, advised her to do something on her own. The neighbor suggested that she visit the local NGO office, as she had heard that NGOs provide training and financial support to poor rural women. Following the advice, M went to the NGO office and learned about worm composting training being offered by BRAC's Shongram project facilitators. She had no prior knowledge of worm composting, but NGO workers encouraged her to join the training. Through the training, she gained new skills and knowledge, which helped her become more confident. After completing the training, she decided to start her own worm composting business. She requested financial support from the NGO, and they provided her with a loan of 10,000 taka. With this money, she began her business. A week later, she visited the NGO office again, where the workers continued to motivate her and introduced her to other successful women entrepreneurs. They assured her that they would always be available if she needed help. Now, M earns her own income, manages her savings, and can spend money independently. Her family no longer lives in poverty. Her children attend school regularly and have enough to eat. She has become an inspiration for other women in her community. M is now very happy with her family, and according to the local NGO, she is considered a successful woman in Gaurichanna Union.

3.2.1.6 Fruit tree cultivation

In study area, women have long been involved in the cultivation of fruit trees besides the household areas and agricultural land. Women engaged in different fruit tree cultivation such as papaya, guava, jackfruit, coconut, banana, lemon, watermelon, hogplum etc. In spite of their interest in cultivating fruit trees but could not proceed due to lack of cultivated land. Among the respondents maximum women received training from NGO

(BRAC). Women already take part in a community season to know which crops and varieties have more resilience to the growing environment. These women are very eager to increase their knowledge on the nutritional content of different food items and are aware of the importance of income generating activities of family. Rural women used to prefer this type of work for the growth of plant by small watering in the evening time.

3.2.2 Non-agriculture based income generating activities (IGAs)

Income generating activities (IGAs) undertaken by women in the study area included the most important non-agricultural income generating activities undertaken by women in the study area. According to the Fig. 5 of non-agricultural based livelihood pattern of the study area it shows that most of women income source is Rice/paddy husking 68%, Tailoring 45%, Handicraft 62%, Daily worker 50%, Running small business 35%, street vendor 10% etc.

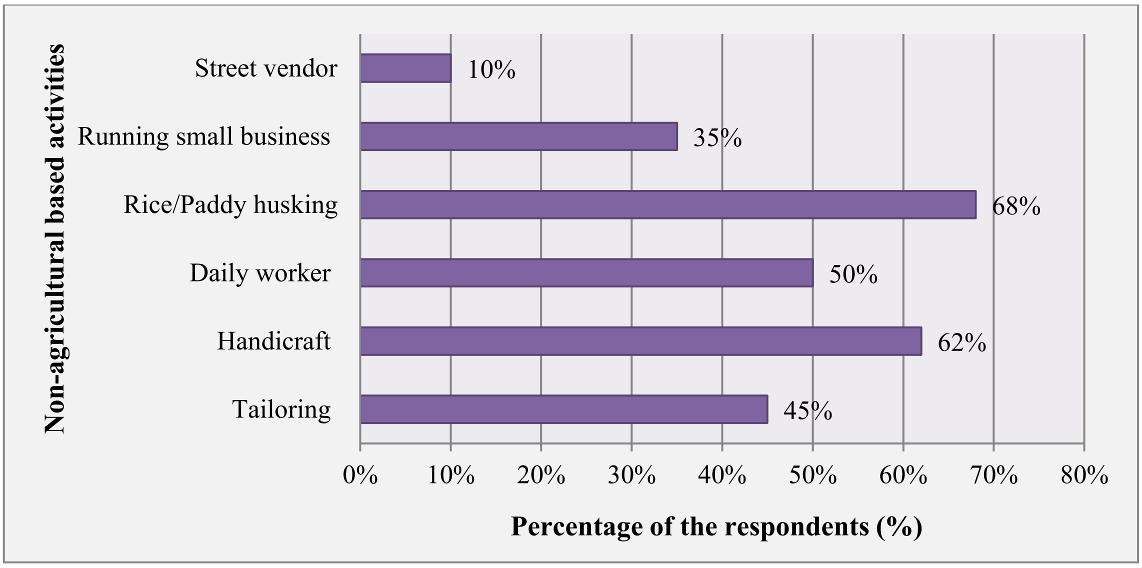

Fig. 5. Non-Agricultural Based Livelihood pattern of the study area.

The average monthly income of respondents based on non-agricultural activities is given bellow. The Table 4 states that the average monthly income is high in Tailoring (dress making, Nakshikhata, wallmet) and low is street vendor (selling various products such as cloths, puffed rice, pounded rice, dry fish, egg, vegetables, milk, honey, soap).

Table 4. Average monthly income of respondent

Source of income	Average monthly income (BDT)
Tailoring (dress making, nakshikhata, wallmet)	9,000 Tk
Handicraft (basket, mats, nets, dala, chalun, kula, sika, jharru)	3,500 Tk
Daily worker (domestic helpers in other people's houses, road constructing, brick-breaking work, bhangari sold)	4,500 Tk
Rice/Paddy husking	3,000 Tk
Running small business (grocery shop, firewood business)	7,000 Tk
Street vendor (selling various products such as cloths, puffed rice, pounded rice, dry fish, egg, vegetables, milk, honey, soap)	1,500 Tk

3.2.2.1 Tailoring (dress making, embroidery, nakshikhata, wallmet)

In the study area, rural women especially widow and divorced are being self-reliant and permanent employment through training of tailoring. The training of the women of first phase has almost completed and presently the women are preparing themselves to start their own income generating activities as per their training. Women would be able to run their own business successfully with their own amount applying and acquired knowledge.Through interview, it is known that with their savings and training on tailoring, as well as the strengthened position they find themselves within their communities that the women are lifting themselves out of poverty level.

Case study 2, utilization of training and earning income. M, a 31-year-old woman, lives in Betbunia village of Gaurichanna Union in Barguna Upazila. She studied up to grade six and has a family of five members. Her husband, H, is 40 years old and works as an auto-rickshaw driver. They have three children: two daughters, S (13) and S (10), and a son, K (7). They are studying in grades seven, four, and two, respectively. M has been married for 15 years. About eight years ago, her family separated from their large joint family and began living independently. After starting this nuclear family life, she found it very difficult to manage day-to-day expenses. Since they had very little land for cultivating a homestead garden or raising poultry, cattle, and goats, it was hard to meet the family's basic needs. She had to depend entirely on her husband's income to run the household while she took care of all domestic chores and small farm activities. One day, she heard about tailoring and embroidery training being provided by BRAC's Shongram project facilitators. She decided to join the training to learn new skills and earn some money. After completing the training, she gradually became involved with a women's group called the "Village Bank" and began participating in community social work. For the past five years, she has been saving 100 taka each month and now serves as the president of that group. In addition, she is also involved in savings activities with three other groups and NGOs. After completing her tailoring and embroidery training, she started her own small business. Marufa believes that the training has greatly improved her daily life. She now works actively alongside others in her community, and her family life has become much easier than before. She can afford her children's educational expenses and buys them daily tiffin for school. Previously, she had to rely on her husband for these expenses, and when he couldn't provide money on time, the children would feel sad and embarrassed because their school fees were overdue and they couldn't bring tiffin. Now, her children are happy, and she feels deeply satisfied. In the past, M was shy and hesitant to speak in front of others or share her problems with anyone. But now, things have completely changed. She has participated in health, disaster, and education-related training programs organized by "SAFE Bangladesh," where she openly discussed her problems and learned how to solve them. Today, M motivates other women in her community not to remain idle or afraid to express their needs and concerns within their families or in society. Her husband fully supports her activities and savings initiatives. She now leads a happy and content life, earning an income through her tailoring business and serving as an inspiration to other women in her community.

3.2.2.2 Handicraft (basket, mats, nets, dala, chalun, kula, sika, jharru)

Handcrafts are traditional activities of young women in the study area. According to the respondent's information, domestic handicrafts are the easiest process of income generating activities. A number of non-agricultural based activities, such as bamboo product-making (handicraft), mat making were also conducted by the communities in the study area. Women are being so much benefited by this activity. It is found that 62% of sample respondents of women were graduated from their extreme poor condition and enabling to fulfill basic needs of their families through the involvement with diversifying or alternative livelihoods.

3.2.2.3 Daily worker

In study areas, women especially divorced or widow who are landless, and lives in a slum area, those women are engaged in many daily worker activities (domestic helpers in other people's houses, road constructing, brick-breaking work, bhangari sold). Brick-breaking work is a better income than agriculture or other jobs, but it is risky and often devastating to workers health. Lack of education is considered one of the barriers for development of this community. Most of the household's economic status was lower and their children's were involved with economic activities without completing the primary education in Gourichanna union.

3.2.2.4 Rice/Paddy husking

'Rice and Paddy husking by dheki' was another important activity done by the rural women either regularly or occasionally. A dekhi is a tool used for threshing, to separate rice grains from their outer husk, while leaving the brown layer, thus producing brown rice. In earlier times dekhi was an important part of village life in rural women. The women who were very poor and those who have no alternative source of earning were involved in different types of work for improving their livelihoods. There are many reasons behind the involvement of rural women labor in various non-agricultural activities. The causes are not mutually exclusive and the main causes found to be responsible in study area were to meet family needs, absence of male earning members, to increase family income, to meet personal needs and to meet additional family requirements. It is apparent that the larger the size of the family the higher the extent of participation of women in outside activities. Level of education of the respondent and the size of the landholding were negatively associated with the women's involvement in income generating activities. Women participation decreased with the increase of level of education and size of landholding.

3.2.2.5 Street vendor

In the study area, women who are very poor, landless, and illiterate and those who have no alternative source of earning, they are involved in various street vendor (selling various products such as cloths, puffed rice, pounded rice, egg, vegetables, milk, honey, soap) activities. Most of the respondents who are involved in street vendor live in slum area at Gaurichanna union in Barguna district. There is no land for poultry rearing, homestead gardening, cattle and goat rearing, fruit tree cultivation and no initial capital for running another business those are already practiced in this community. In spite of their interest of non-agricultural based activities, they cannot receive loan from NGO because they cannot pay the loan through their income. But Government has another strategy to help the poor women who lived in slum area that is the VGD and VGF card. By showing the card poor women can buy the necessary things in lower cost.

3.2.2.6 Running small business: (grocery shop, firewood business)

Rural women's economic and social development is necessary for overall economic progress of society and nation. In study area, it is rear to see women running a grocery shop or a business because of family restrictions, social and traditional barriers. Given the barrier faced by women in this community, rural women are now increasingly run their own business and encouraged their neighbors to step forward and work to lift their families out of poverty level. It is indicates that self-business leads to self-fulfillment and makes women aware about their status, existence, right and their position is in the society. Most of the respondents have informed that women are being involved in income generating activities outside the home and to earn own income, become less dependent on husband, to assist husband financially in supporting the family and increase their family status.

3.3 Contribution of women's income generating activities to household and community disaster resilience

The climate disaster resilience consist of five dimensions and they are Physical, Social, Institutional, Economic and Natural (Joerin & Shaw, 2011; Prashar et al., 2012). Mukherjee et al. (2020) revealed that if education level could be increased, awareness about natural or man-made hazards would automatically increase and it would enhance future resilience. The study also revealed that rebuild or repair houses, awareness of people, savings, health care, food security, livelihood security, social relations, bonding, and cooperation to survive after any disaster enhance community resilience (Mukherjee et al., 2020). Table 5 presents how income earned by women through income-generating activities (IGAs) is utilized at the household level and how these spending patterns relate to different dimensions of disaster resilience. The analysis is based on the resilience framework proposed by Joerin & Shaw (2011), which highlights physical, social, institutional, economic, and natural dimensions of resilience. By examining how households allocate income generated through women's IGAs, the study identifies several livelihood-related indicators that contribute to strengthening adaptive capacity and improving resilience to disaster-related shocks.

Table 5. Money spending purpose and moving towards resilience

Purpose of Spending Money Earning from IGAs	Responded Percentage	Fulfill the Dimensions of Resilience (Physical, Social, Institutional, Economic, Natural)
Child Education	90	Fulfill Social, Economic, Natural and Institutional Dimension of Resilience- Ensuring secure livelihood Promoting access of technologies Understand early warning and awareness Ensure sustainable environmental management Establishing contingency and emergency planning. Improving understanding of trends and their local impacts
Repairing House/Infrastructural	30	Fulfill Physical Dimension of Resilience- Ensuring secure living condition Improving hazard prevention and protection
Savings	60	Fulfill Economic Dimension of Resilience- Building back better
Health Care and Food Security	80	Fulfill Social Dimension of Resilience- Ensure primary health care Ensure three times meal daily
Lend	10	Fulfill Economic and Social Dimension of Resilience- Strengthening links between community Improving of social bonding
IGA Equipment	65	Fulfill Physical and Economic Dimension of Resilience- Ensuring secure livelihood condition Promoting access to technologies Learning and building back better

According to the Table 5, the total monthly household income spend in educational purpose, repairing house / infrastructural purpose, savings, health care & food security, lend and IGA equipment. Most of the rural women in the study area also mentioned that they spend more money for educational purpose of their children. About 90% women (Table 5) spend their earned money on their children's education. They want to ensure good education to their children. Education is an important factor for Income Generating Activities (IGAs). Half of the monthly income of rural women spend for education sector and goes their children towards primary education. They increase the literacy rate in rural areas that improves the human capital and fulfill the livelihoods diversity and security, effective responses to shocks and stresses, understanding and adapting to future uncertainty in resilience framework that we can say that it increases Disaster resilience in the study area of Gaurichanna Union.

On the other hand, about 30% (Table 5) women spend their earned money on repairing house/infrastructural purpose. Figure-9 shows that at present, 45% semi-pucca and 3% pucca house in the study area of Gaurichanna Union after involving women in Income Generating Activities (IGAs) that are increasing their physical capital in aspects of achieving resiliency. The improving of house/infrastructural like semi-pucca and pucca house protect the house from disaster, effective responses to shocks and stresses in resilience framework that we can say that it increases Disaster resilience in the study area. About 60 percent (Table 5) women are involving with savings and such savings practice has brought manifolds positive impact in the way of lives of poor family. In the study area, the overall household savings were very small. Savings performance varied significantly among the two categories of rural women: "NGO women" saved more money compared to the "non-NGO women". A saving account is mandatory for the member of NGO. To save money every week is compulsory and each member has to pay at least Tk. 10 per week in the group savings fund. Financial capital improves by savings and fulfills the livelihoods diversity and security, effective responses to shocks and stresses, good governance in resilience framework that we can say that it increases Disaster resilience. About 80 percent (Table 5) women spend their earned money on service of their family. WASH techniques which are improving their access to basic sanitation, safe water and hygiene. In the study area, it is found that communities are included in decision making processes and all WASH technologies are gender equitable, easily accessible to women, people living with disabilities, adolescents, children and the elderly. They increase their knowledge on the nutritional content of different food items and are aware of the importance of income generating activities of family. They have changed their previous conditions after involving Income Generating Activities (IGAs) and they secured three times foods per day. Most of the rural women improve their health care and food security through different GO and NGO training activities. Health care and food security service is related to the social dimension. The improving of social dimension fulfills the livelihoods diversity and security, understanding and adapting to future uncertainty in resilience framework that we can say that it increases Disaster resilience in the study area. About 10 percent (Table 5) women to help their neighbors through lend money/equipment. Women in all the communities of the study area do almost all of the household works. Beside the household activities they are involved in farming, off-farm activities, domestic expenditure and other social activities. By this earned money, maximum income spends their family purpose and savings. So, they are very small amount of money lent their neighbors. Through lend money/equipment increase in effective social safety nets. Lend improves the social bonding and fulfills the good governance in resilience framework. We can say that it increases Disaster resilience in the study area. About 65 percent (Table 5) respondents mentioned that they spend their money in buying equipment's of Income Generating Activities. Few number of women used own resources such as bamboo product-making (handicraft) and improve capacity building of earning. The improving of physical capital fulfill the livelihood security with investment for the future, effective response to shocks and stresses in resilience framework that we can say that it increases resilience.

The findings indicate that women's participation in income-generating activities contributes to strengthening several components of household resilience. A large proportion of respondents reported spending income on children's education, health care, and food security, which enhance human capital and social resilience. Investments in housing repair and livelihood equipment improve physical and economic resilience by strengthening shelter conditions and productive assets. Similarly, savings practices help households build financial reserves that can be used during emergency situations. These spending patterns indicate that women's income-generating activities not only contribute to immediate household needs but also strengthen key livelihood assets that enhance the capacity of households to prepare for, cope with, and recover from disaster-related shocks.

3.4 Discussion

The findings of this study demonstrate that women in the coastal communities of Gaurichanna Union are actively engaged in a wide range of agricultural and non-agricultural income-generating activities (IGAs). These activities not only contribute to household income generation but also play an important role in livelihood diversification, adaptive capacity, and household resilience in a disaster-prone environment. The discussion is organized around the two major objectives of the study: identifying the types and patterns of women's IGAs, and examining the contribution of these activities to household livelihood security and community disaster resilience.

3.4.1 Types and patterns of women's income-generating activities (IGAs)

In this study, the income-generating activities (IGAs) of women are divided into two broad categories: agricultural and non-agricultural activities. Sheheli (2012) also notes that the income-generating activities of rural women in Bangladesh can be broadly categorized into agricultural and non-agricultural sectors. The study revealed that the agricultural-based IGAs of women include homestead gardening, poultry rearing, cattle and goat rearing, pond fish culture, worm composting, and fruit tree cultivation (Figure 2). This reflects the gendered livelihood structure of rural Bangladesh, where women's economic participation is often shaped by cultural norms, mobility restrictions, limited access to land, and household responsibilities. The study further shows that livelihood diversification is an important survival strategy in coastal disaster-prone areas. Women are not dependent on a single source of income; rather, they engage in multiple livelihood activities to reduce economic vulnerability and cope with environmental uncertainty. Similarly, Sheheli (2012) identified agricultural IGAs such as homestead vegetable cultivation, crop production, post-harvest agricultural activities, poultry rearing, livestock management, fisheries, beekeeping, and sericulture. The present study found that homestead gardening is the main agricultural activity among women, with 95% of respondents engaged in it. Hasan et al. (2015) reported that 100% of respondents cultivated vegetables seasonally on their fallow lands and in the backyards of their homesteads. Similar findings were also reported by Shameem & Kalam (2018). Millat-e-Mustafa et al. (2000) further observed that pond sides, backyards, and cowshed areas of homesteads are often used for vegetable cultivation. These activities are proven to be very important IGAs for rural women. Findings from Khan et al. (2009) indicate that homestead gardening is the leading agricultural activity among Bangladeshi rural women, occupying the largest share of poor farmers' livelihood resources (Ali et al., 2008). The study also revealed that 90% of respondents are involved in home-based poultry rearing (such as hens, ducks, swans, and geese), which remains a traditional practice for almost every rural family. Islam et al. (2003) reported that about 89% of rural households rear poultry. Hasan et al. (2015) found that 86% of respondents raised poultry as an IGA. Rahman (2003) also identified poultry production as an important income-generating activity carried out by women in Bangladesh, playing a vital role in improving household income. In rural areas, women own about 94% of the poultry. Poultry production among poor rural households contributes significantly to income, nutrition, food security, savings, and informal insurance mechanisms (Nielsen et al., 2003; Sonaiya, 2007). Furthermore, the study revealed that 70% of respondents are engaged in cattle and goat rearing as IGAs and as a means of gainful employment. Islam (2008) noted that a common practice among poor women in Bangladesh is rearing animals on a share basis, where poor women rear livestock owned by wealthier families in exchange for a 50% share of the offspring or profits. Several studies (Jahan & Rahman, 2003; Parveen, 2008) support that livestock management in Bangladesh is primarily carried out by women. Their responsibilities include grazing, feed preparation, feeding, cleaning of the animals and sheds, and sometimes milking cows.

According to the findings (Figure 5), women in the study area are also engaged in several non-farm IGAs, including rice/paddy husking (68%), tailoring (45%), handicrafts (62%), daily wage labor (50%), small businesses (35%), and street vending (10%). These non-agricultural activities are vital sources of income for women in the area and also provide important opportunities for women's economic participation, particularly for landless, widowed, or economically vulnerable women. These activities increase women's financial contribution to the household and gradually strengthen their decision-making power and social participation within the community. Thus, women's involvement in IGAs should not only be viewed as an economic activity but also as a process of social empowerment and community development. Hasan et al. (2015) found that women in similar areas engaged in activities such as bag making, handicrafts, wall mats, flower decoration, and puffed rice production and sales. Al-Amin (2008) also identified non-agricultural IGAs such as self-employment through handicrafts (dressmaking, wall mats, household accessories, basket making, jute bags, bamboo work, and embroidery) and cigarette production. Some women run small businesses such as shop keeping. Other studies (Fakir, 2008; Farid et al., 2009) found that some women operate grocery shops (especially those attached to their homes) or travel from village to village selling clothes and other goods. The poorest women engage in work such as collecting firewood, laboring in brickfields, and working on road construction or in rural industries. Women are also involved in rice/paddy trading, rickshaw renting, studio work, preparing and supplying fishing nets, and producing other fishing-related materials (Sheheli, 2012).

3.4.2 Contribution of women's IGAs to household livelihood security and community disaster resilience

The findings of this study suggest that women's participation in income-generating activities contributes significantly to household livelihood security and adaptive capacity in coastal disaster-prone areas. Although the study does not claim a direct causal relationship, the evidence indicates that households engaged in diversified IGAs are better able to cope with economic and environmental shocks. Women's income from IGAs was commonly used for children's education, food consumption, healthcare, housing repair, savings, and investment in productive assets. These expenditures contribute to strengthening different dimensions of household resilience, including economic stability, food security, physical safety, and social well-being. In particular, savings and diversified income sources help households manage post-disaster recovery costs and reduce dependence on external assistance. The findings also demonstrate that participation in IGAs enhances women's adaptive capacity by improving livelihood skills, access to social networks, and engagement with NGO-supported training programs. Women involved in IGAs were found to participate more actively in household decision-making processes and community-level activities. This increased participation contributes to social resilience and community development by strengthening cooperation, knowledge sharing, and local support systems. In coastal regions such as Barguna, where communities frequently experience cyclones, flooding, and livelihood disruptions, diversified livelihood strategies are particularly important for reducing vulnerability. Therefore, women's participation in IGAs can be understood as an important component of household-level adaptation and resilience-building rather than only an income-support mechanism.

4. Conclusions

This study explored the types of income-generating activities (IGAs) practiced by rural women in Gaurichanna Union of Barguna District and examined how these activities contribute to household livelihood security and disaster resilience in a coastal hazard-prone environment. The findings indicate that women are actively engaged in a wide range of agricultural and non-agricultural livelihood activities, including homestead gardening, poultry rearing, cattle and goat rearing, pond fish culture, worm composting, fruit tree cultivation, rice/paddy husking, handicrafts, tailoring, daily wage labor, street vending, and small businesses. These activities provide important opportunities for income generation, livelihood diversification, and economic participation for rural women. The study found that women's participation in IGAs contributes to improved household income, savings, food security, children's education, housing improvement, and investment in productive assets. These livelihood improvements enhance household adaptive capacity and help families cope more effectively with environmental and economic shocks in disaster-prone coastal areas. In particular, diversified livelihood practices and women's economic participation reduce vulnerability by strengthening financial stability and supporting local coping mechanisms. However, the study does not claim a direct measurement of community-wide resilience outcomes; rather, it demonstrates how women's livelihood strategies contribute to household-level resilience and adaptive capacity within the local context. The findings also highlight the importance of women's empowerment in community development processes. Participation in IGAs increases women's access to livelihood skills, social networks, savings practices, and decision-making opportunities within households and communities. Therefore, women's income-generating activities should be understood not only as economic practices but also as gendered livelihood strategies that support resilience-building in vulnerable coastal communities. Based on the findings, the study recommends that policymakers, NGOs, and local government institutions strengthen women-centered livelihood development programs in coastal regions. Greater support is needed in areas such as livelihood training, microcredit access, climate-resilient agricultural practices, market linkage development, and disaster preparedness education. Integrating women's livelihood activities into local disaster risk reduction and community development planning may help strengthen adaptive capacity in hazard-prone rural areas. This study contributes to the existing literature by linking women's livelihood activities with household resilience and adaptive capacity in a coastal disaster-prone context in Bangladesh. Future research may expand this work by conducting comparative studies across different coastal districts, applying larger and more representative samples, and using longitudinal approaches to better understand the long-term contribution of women's income-generating activities to disaster resilience and sustainable rural development.

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Author Contribution
M. F., Conceptualization, Supervision, Data curation, Formal analysis, Methodology, Resources, Software, Validation, Visualization, Investigation, Writing–original draft, Writing–review & editing. T. A. T., Conceptualization, Data collection, Formal analysis, Methodology, Software, Validation, Visualization, Writing–original draft, Writing–review & editing. T. A., Conceptualization, Analysis, Investigation, Writing–review & editing.

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During the preparation of this work, the authos used ChatGPT to assist in improving grammar, clarity, and academic tone of the manuscript. After using this tool, the authors reviewed and edited the content as needed and took full responsibility for the content of the publication.

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