Original Research Article

Impact of Native Date Palm (*Phoenix Sylvestris*) Based Agroforestry Practice for Livelihood Improvement and Biodiversity Conservation: Insights from South-Western Zone of Bangladesh

ABSTRACT

This study aims to explore the impacts of native date palm (*Phoenix sylvestris)* based agroforestry practices on the livelihood status and biodiversity conservation practices in south-western zone of Bangladesh. To conduct this exploratory study, data were collected from 70 farmers of Chaugachha upazila (sub-district) under Jessore district of Bangladesh using a pre-tested structured questionnaire during the period of May to June 2022. Findings of the study revealed that a wide range of plant species were available in the study area. Among these plant species, palms comprised the highest proportion (42%) while native date palm (*Phoenix sylvestris)* is the most dominant (38%) among the palm species. It is evident that native date palm based agroforestry practice has significant contributions to improve the livelihood of rural farmers, as majority of the farmers (47%) had moderate status of livelihood improvement while 32% of the farmers had high status of livelihood improvement. Despite facing a variety of challenges, the farmers are willing to continue this agroforestry practice in order to get benefits from a wide range of aspects (human, social, natural, physical and financial). Most of the farmers of the study area depends on traditional knowledge and practices to manage their agroforestry system. So, proper initiatives need to be taken by the policy makers with provision to participatory training on improved agroforestry management practices and input support services (e.g. planting material, fertilizer, irrigation facility, farm equipment etc.). Priority should be given to ensure easy access to marketing and value chain system for the farmers to make this agroforestry practice economically profitable and a viable option for the rural farmers. This will also lead to develop a sustainable biodiversity management system in Bangladesh.

Keywords: Date palm (*Phoenix sylvestris); agroforestry; livelihood; biodiversity; conservation; Bangladesh*

1. INTRODUCTION

"Bangladesh is an agrarian country where agriculture sector contributes 11.63% in the GDP" [1]. "Rice is the staple food of about 135 million people of Bangladesh. It provides nearly 48% of rural employment, about two-third of total calorie supply and about one-half of the total protein intake of an average person in the country. Rice sector contributes one-half of the agricultural GDP (Gross Domestic Product) and one-sixth of the national income in Bangladesh. About 75% of the total cropped area and over 80% of thetotal

irrigated area is planted to rice. Thus, rice plays a vital role in the livelihood of the people of Bangladesh. Sustainability of rice production is at risk due to unavailability of water" [2]. The climate of Bangladesh is not wet enough to support rice crop and sources of irrigation water are decreasing due to drought and desertification. High land rice fields have already been converted to orchards to deal with water scarcity [3]. The problem of water scarcity is increasing due to climate change and decreasing upstream water flow. There is ample scope for mass introduction of date palm in the rice-growing high lands of northwest and south-western part of Bangladesh. The palm family (Palmae, or more recently Arecaceae), constituted of about 2200 plant species, is distributed throughout the tropics and subtropics [4] representing an integral and important part of tropical forests [5]. "Bangladesh is situated in the tropical region and also houses a number of palms distributing from hilly topography through plain lands to the muddy mangrove forests. Among the palms ever found in Bangladesh, the wild date palm (*Phoenix sylvestris Roxb*), locally known as *Khejur*, is one of the most common palms and a well-known source of sugar" [6, 7]. "It grows in a wide belt from the Atlantic Ocean through the Sahara, the Arabian Peninsula into Iran and Indus Valley in Pakistan with their main centers of production" [8]. It has long been one of the most important plants in arid, desert areas of northern Africa, the Middle East and Southern Asia [9] providing food, ornament, material for shelter, fiber and fuel in a harsh environment where relatively few other plants are able to grow [10]. "Even it does not require sun to flourish as it has the great capability of thriving under shade. Such versatility has given it an endurance to resist the negative influences which affect its economic development" [11].

Palm is one of the important horticultural crops in many countries [7, 12]. "In Bangladesh, at least 20 species of palm grow naturally. Among them the most common species are wild date palm (*Phoenix sylvestris*), palmyra palm (*Borassus flabellifer*), betel nut (*Areca catechu*) and coconut (*Cocos nucifera*), which are distributed throughout the country. Coconut is economically important and has the greatest number of uses in Bangladesh"

[13, 14]. “Palmyra palm, locally known as *tal* or *daab*, also has multiple uses” [15]. “Betel nut is commonly produced along pond and canal banks, roadsides in village areas and around homes. It can be chewed alone, but the usual practice is to wrap small slices or pieces of the nut in a leaf of betel pepper, to which lime is added. It is used after meals and on special occasions. In Bangladesh, the wild date palm locally known as *Khejur* is produced as a homestead crop; however, it grows naturally or is cultivated in fallow lands, around homesteads, farmland boundary and even in the marginal lands along the roads and canals. In certain parts of the southwestern region, it is cultivated in orchards by planting seedlings” [16].

“In the crop fields, palm tree is found on the *ails* (slightly raised embankments used as border of crop fields) and also within the fields along with other crops” [17]. “Sap from wild date palm (*Phoenix sylvestris)* has been used from time immemorial to produce traditional sweeteners, a mainstay of *Bangalee* cuisine” [18]. “Because of the extensive use of its sap in making sugar, it is of considerable importance for the household economy in Bangladesh, where cultivation of the palm for tapping is an age-old practice” [19]. “The palm can be tapped regularly and year after year for long time with a small amount of investment for maintenance” [6]. “Some species of Phoenix are able to produce sap all the year round but date palm (*Phoenix sylvestris)* only seasonally” [20]. From the review of previous literature it was found that some studies were conducted on to investigate the status and potential of palm husbandry in rural Bangladesh [21]; traditional utilization of wild date palm [22]; oil palm cultivation improves living standards and human capital for smallholders in Indonesia [23] and sustainable agroforestry practice in Bangladesh [24]. Another study was done by [25] on socio-economic and medicinal value of wild date palm in India while [26] accomplished an study on economic impact of eucalyptus plantation in Gujarat, India. As far we know, no study was has been conducted to investigate the impacts of native date palm (*Phoenix sylvestris*) based agroforestry practice for livelihood improvement and biodiversity conservation covering the geographic area of Bangladesh.

So, this study is an attempt with the specific objectives to explore the role of native date palm (*Phoenix sylvestris*) based agroforestry for livelihood improvement of farmers and biodiversity conservation in Chaugachha upazila (sub-district) under Jessore district of Bangladesh.

2. THEORETICAL APPROACH OF THE STUDY

Livelihood refers to those things (marginal and social) that allow a person to live well, or prevent a person from doing anything against development. It indicates clean water, shelter and access to health care and education, access to credit facilities and virtually anything that would contribute to gain a better life. Livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. The sustainable livelihood approach of the Department for International Development [27] is inherently responsive to people's own interpretations of and priorities for their livelihoods.

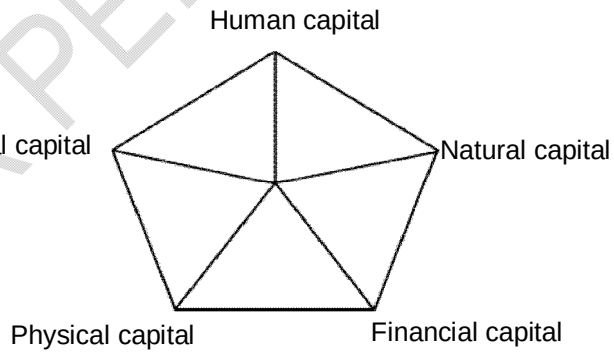

Fig. 1. Livelihood assets pentagon [27]

A framework for analyzing sustainable livelihoods, define in relation to five key indicators: Increasing number of working days created, poverty reduced, well-being and capabilities improved, livelihood adaptation and resilience enhanced and natural resource based sustainability ensured [28]. The framework shows how in different contexts, sustainable

livelihood is achieved through access to a range of livelihood resources (human, social, natural, physical and financial) which are combined in the pursuit of different livelihood strategies.

3. MATERIALS AND METHODS

3.1 The Study Location

The study was conducted in the Chaugachha upazila (sub-district) under Jessore district of Bangladesh (Fig. 2). Chaugaccha upazila (sub-district) has an area of 269.20 sq. km. sub-division is located in between located in between 23°10' and 23°22' north latitudes and in between 88°54' and 89°08' east longitudes. It is bounded by maheshpur, kotchandpur and kaliganj (Jhenaidaha) upazilas on the north, sharsha and jhikargachha upazilas and west bengal state of India on the south, jessore sadar and Kaliganj (Jhenaidaha) upazilas on the east, Maheshpur upazila on the west [29]. Chaugaccha upazila has a total population of 211,065 with a literacy rate of 43.92% [30]. Geographically, the Chaugachha sub-division is located in Agro-ecological zone 16 (Middle Meghna River Floodplain), characterized by medium high land topography and surrounded by Meghna river with a maximum annual average temperature is 35°C and minimum 14°C with a yearly rainfall of 241 mm [31]. The study area was selected because native date palm based agroforestry is more prominent and a common scenario in this area while most of the people (72.94%) of this locality depend on agriculture for their livelihood. Moreover, well developed communication facilities, co-operative and helpful attitude of the farmers involved in date palm based agroforestry motivated the researcher to select the study area. Two villages namely Jagadishpur and Hakimpur under Chaugachha upazila (sub-district) were selected purposively for this conducting this study.

3.2 Population and Sampling Design

The main focus of the study was to investigate the impact of native date palm based agroforestry practice on the rural farmers of the study area. To have an in depth understanding about the impact of date palm based agroforestry practice based on real scenario, the rural farmers of the study area who were involved in date palm cultivation was considered as the population of the study. An updated list of farmers of the study area involved in date palm cultivation practice was collected from local Upazila Agriculture Office. The total number of farmers of the study area involved in native date palm cultivation was 250, among them 70 respondents were randomly selected as the sample of the study by using the following formula [32] (Equation 1):

$$n = N / (1 + N (e) 2) \quad (1)$$

Where, n = sample size, N = population size, and e = level of precision which indicates the degree of error or statistical variability

Fig. 2. Map of Chaugachha upazila showing study area [29]

3.3 Methods of Collecting Data

To accomplish this research, data were collected by using a combination of different methods such as survey method, group discussion method, key informant interview and observation method. In case of survey method, a pre-structured questionnaire was used as data collecting instrument which contained both open and closed forms of question. Data were collected from the respondentsfrom the period of May to June, 2022.

3.4 Measurement of Variables

To have insights about the distribution of commonly found plant species and the proportionate distribution of different palm species, percentage (%) and frequency distribution were used. Livelihood improvement status of the farmers was the focus variable of the study. A five point rating scale was developed to measure the livelihood status of farmers in case of five livelihood capitals (human, social, natural, physical and financial capital). Specific score wasassigned to measure the livelihood change such as +1, +2, +3, 0 and -1 for 'slightly improved', 'moderately improved', 'highly improved', 'unchanged' and 'decreased' respectively [33]. The specific score of the scale such as slightly improved (1), moderately improved (2) and highly improved (3) indicates the degree or level of improvement occurred in case of each livelihood capitals due to date palm based agroforestry practice. Five dimensions were used to measure each livelihood capital of farmers. So, the score range of each livelihood capital could vary from -5 to +15. The dimensions for each capital were selected through the study of the previous literature, book review and consultation with the experts. So, the score of each livelihood capital was measured by using the following formula:

Hence, Livelihood Capital Score (LCS)= $3\times HI+2\times MI+1\times SI+0\times U+(-1)\times D$

Where,

HI = Total number of respondents expressing their opinion as 'highly improved'

MI = Total number of respondents expressing their opinion as 'moderately improved'

SI= Total number of respondents expressing their opinion as ‘slightly improved’

U = Total number of respondents expressing their opinion as ‘unchanged’

D = Total number of respondents expressing their opinion as ‘decreased’

In case of human capital five dimensions are food availability, nutritional security, health condition, knowledge and skills and capacity development. To measure social capital the dimensions are social networking, innovativeness, mutual trust, neighborhood connection and involvement in farmers’ group were used. The dimensions named status of date palm orchard, soil-crop interaction, management of available resources, biodiversity conservation practice and date palm products were used to investigate natural capital. To explore physical capital the housing status, source of drinking water, sanitation facilities, ownership of electronic devices (mobile phone, television, computer etc.) and farm machinery like power tiller, tractor, deep tube well etc. were confirmed and used. The financial capital of farmers were measured through household income, purchasing capacity, bank deposit, household savings and ownership of useful assets [23, 24, 34]. The livelihood status score of the respondents was measured by summing the total score of five livelihood capitals (human, social, natural, physical and financial capital) by using the following formula:

So, Livelihood Status Score (LSS)= HCS+SCS+NCS+PCS+FCS

Where,

HCS= Human capital score

SCS= Social capital score

NCS= Natural capital score

PCS= Physical capital score

FCS= Financial capital score

So, according to the above mentioned formula, total livelihood status score of each respondent could vary from -25 to +75.

3.5 Data Processing and Analysis

The collected data were properly edited, coded, compiled, and analyzed based on the objectives of the study. All inconsistent data were avoided to eliminate the errors and fault. The qualitative data were converted into quantitative one whenever necessary. SPSS (Statistical Package for Social Sciences) version 22 computer program was used to process all the collected information in the computer. Descriptive statistical methods like range, frequency, percentage, mean, and standard deviation, charts and graphs were used.

4. RESULTS AND DISCUSSION

4.1 Present Scenario of Homestead Plant Diversity

In the study area, a wide range of species are traditionally cultivated in the homestead areas. The most commonly found species are mango, native date palm (*Phoenix sylvestris*), coconut (*Cocos nucifera*), betel nut (*Areca catechu*), jackfruit (*Artocarpus heterophyllus*), guava(*Psidium guajava*), papaya (*Carica papaya*), koroi (*Albizia procera*) and palmyra palm (*Borassus flabellifer*). It is evident from the Fig. 3 that palm comprises the highest percentage (42%) of the plant species. The most commonly cultivated palm was wild date palm, coconut, betel nut and palmyra palm. The other species that are mostly commonly found in the study area was mango, mahogoni, eucalyptus, jackfruit, koroi, raintree, guava, papaya and berry accounts for 10%, 8%, 7%, 9%, 6%, 5%, 4%, 6% and 3% respectively. Palms were popular because there was readily available propagative material (seeds) and they require little care. Farmers primarily cultivate palms for sale and personal consumption. Most of the palm trees were located along roadsides, ponds and canal banks, ails and generally scattered around the homestead garden. The findings is also supported by [21] in case of southeastern region of Bangladesh.

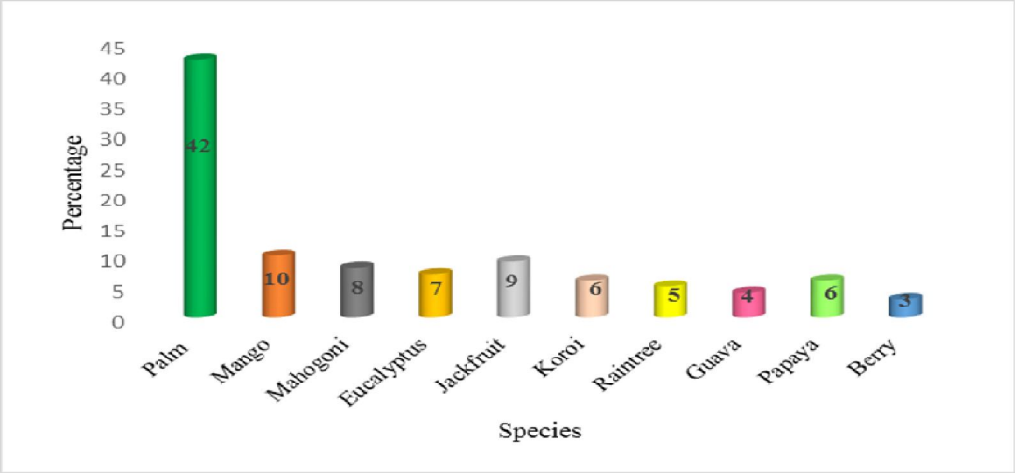

Fig. 3. Diversity of commonly found plant species in the study area

Among the palm species native date palm was the most commonly cultivated species (38%) those are found along roadsides, pond banks, crop fields, canal banks and also in the fields of other crops. Coconut was the second most commonly cultivated species (30%) found in the homestead areas, roadsides, bank of ponds, canals and also cultivated with other crop species. Betel nut (22%) was located along pond banks, roadsides and around the home while palmyra palm was (10%) located along roadsides (Fig. 4). These results differ from those of [21] where among the palm species betel nut (48%) is more dominant than the other palm species while [35] found most palms were on canal banks. The findings from another study revealed that the highest occurrence of palms were in orchards followed by homestead [22]. Palms found along roadsides and on public places such as bank of canal, river and pondside are under the direct jurisdiction of the District Commissioner (DC) and those who want to harvest these palms must receive permission from the District Commissioner (DC) to do so. The study revealed that most of the palm orchards and roadside palms were developed by plantation and the rest were grown naturally, which does not require any scheduled maintenance and care. The farmers reported that those would be cared for naturally and those raised in orchards required a little bit of care and management practices. Natural regeneration generally occurs freely by seeds while birds act as the main dispersing agent. It can be regenerated through vegetative propagation by the formation of

offshoots [11]. By nature, the palms are used to produce fruits in winter. After ripening of the fruits a huge number of seeds are found to be dispersed here and there in the vicinity of the palms with the help of various dispersing agents like birds, squirrels, cow, goat and by local people who used to disperse the seeds after consuming fruits.

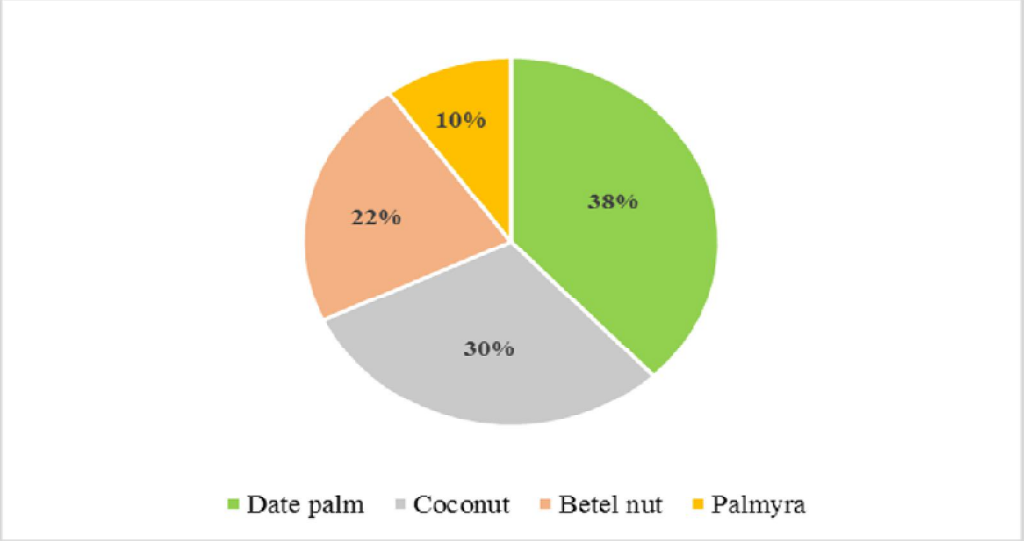

Fig. 4. Proportionate distribution of palm species in the study area

During the rainy season, these dispersed seeds are found to be germinated. However, most of the seedlings are found to be damaged where agricultural crops are grown. The seedlings that are grown in the marginal, fallow or wastelands were found to be grown naturally and able to skip from being damaged. In most cases, farmers used to collect naturally growing seedlings of 1 to 2 years having a height of 15–40 cm. The seedlings are planted immediately after collection by digging the soil and these are grown by proper care and management practices.

4.2 Management Practices of Native Date Palm (*Phoenix sylvestris*)

4.2.1 Planting Method

The majority of the palms in people's backyards and along roadsides were planted and cultivated, but the rest spread out naturally and didn't require any periodic care or

maintenance. Farmers claimed that most of the planted trees require regular care and management practices for their growth but wild date palms that are regenerated naturally do not require any care and maintenance. These results are consistent with earlier research showing that palm farming in Bangladesh is based on sporadic plantings of palm trees and naturally occurring palm trees [35] with natural regeneration happening freely through seeds [36] and birds serving as the primary dispersal agent [37]. Palm trees are planted by local farmers using the conventional methods of planting. In a propagation bed, palm seeds are sown, and after a young shoot appears, they are moved to the actual planting spot. In some cases, seeds are sown directly into the ground. Additionally, the management practices of wild date palms in Bangladesh is based on planted or naturally occurring palms [35]. Both seeds and volunteer seedlings from domesticated and untamed trees are used to grow these palms. Due to the rapid loss of viability of wild date palm seeds, farmers gather *khejur* seeds and promptly plant them in polythene bags in their own gardens. A wide number of palm seeds are distributed once the fruit ripens, where they germinate during the rainy season. From agricultural fields or marginal areas like bank of ponds, canals and *ails* (divider margin between the two fields) farmers gather wild date palm seedlings. When the plants become 1 to 2 years old and 15 to 40 cm in height, these are replanted as soon as they are collected from the above mentioned sources.

4.2.2 Maintenance and Cultural Practices of Native Date Palm (*Phoenix sylvestris*)

Farmers rarely use cultural practices on their own. They frequently hire an expert person (locally called as *gachhi* who has expertise in cultural and management practices of date palm). *Gachhi* are workers who are skilled in extracting palm sap, plant palm trees, and clean and remove epiphytes, unwanted palm leaves, and flower stalks from wild date, coconut and palmyra palms. *Gachhi* regularly collects fruit or sap from *tal gachh* (palmyra

palm) or juice from *khejur gachh* (native date palm). There are now a very small number of *gachhis*, and their work, particularly the collection of sap from untamed date and palmyra palms or the cleaning of epiphytes from coconut palms, is now performed by any rural resident who has acquired the necessary skills. The lack of skilled professionals has reduced the yield of palm products. The skilled person locally called as *gachhi* used to remove unwanted materials (e.g. leaves, stalks and branches) from the date palm tree once a year to increase flowering and fruiting capacity. Similar techniques were used in case of palmyra palm [14].

4.2.3 Harvesting Techniques

Palmyra palms mature at 7 to 8 years old, while betel nut palms mature at 5 to 7 years. That species' fruits are harvested by climbing the tree. Juice is made from young, immature fruits. Tapping for sap from a palmyra palm is done by cutting the outer end of panicles of inflorescence among the leaves at the top of the tree rather than cutting the surface of the tree. A similar sap collection method is being practiced in Dinajpur, Khulna, Joydebpur, and Mymensingh districts of Bangladesh mentioned by [7]. Native date palms are tapped for the first time when they are 5 to 7 years old and they can be tapped for up to 20 years. On one side of the tree, the oldest leaves are removed at the end of October. Using a *Dao* (commonly used cutting instrument) the bases of the petiole and leaf sheath are carefully removed. A triangular piece of pseudo-bark is carefully cut to reveal the sap-supplying inner zone. At this point, a spout is inserted into the tree trunk and a pot is hung at the other end to collect and store the sap. During the winter season tapping is generally done at 5 to 6 pm to collect sap from the date plants.

4.3 Impact of Date Palm (*Phoenix sylvestris)* Based Agroforestry Practice on the Livelihood of Farmers

4.3.1 Change of Livelihood Status of Farmers

Native date palm (*Phoenix sylvestris)* based agroforestry practice plays a key role in providing household food and energy, security, income and employment generation, investment opportunities and environmental protection as well as sustainable livelihood patterns. The overall livelihood status of farmers was calculated by combining the individual score of five livelihood capital (human, social, natural, physical and financial). The findings of the study shows that, the observed score for change of livelihood status of farmers ranged from +18 to +60 while the possible score range was -25 to +75. The average score of change of livelihood status was 34.03 with a standard deviation 8.59. It is evident that most of the participants (47%) belonged to medium status of livelihood improvement while 32% of the respondents belonged to high status of livelihood improvement (Fig. 5).

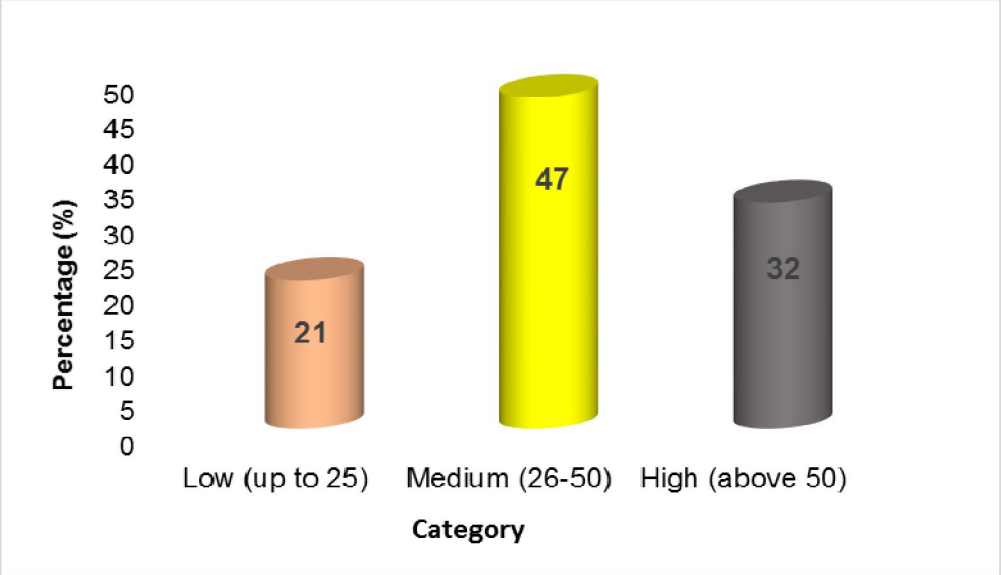

Fig. 5. Distribution of the respondents according to their change of livelihood status

The findings supported by [23] in case of oil palm based agroforestry practice in Jambi province of Indonesia while [24] also found that agroforestry practice has significant contributions in case of rural livelihoods in Jessore district of Bangaldesh. It was also reported that [25] wild date palm cultivation was economically profitable and also reported to have medicinal values. Another study [26] found that eucalyptus plantation is profitable

and also economically a viable option for the farmers of Gujarat province in India. Almost similar finds were also reported by [38, 39, 40] in their respective studies.

4.4 Impact on Biodiversity Conservation

Cultivation of native date palm (*Phoenix sylvestris*) with other tree or crop species has great potential in promoting sustainable farming in the study area. Besides economic benefit, the indirect benefits are providing to improve the sustainable environmental management (e.g. carbon sequestration, improving microclimate, reducing soil erosion) ensure the ecological balance of the whole community. The science and practice of agroforestry is ultimately geared towards promoting sustainable development by improving the socio-economic productivity, environmental sustainability and accelerated livelihood pattern of the practitioners without sacrificing the environment, particularly the forest and agricultural resources. The environmental services provided by this agroforestry practice will provide a healthy environment for future generation. This will also help to combat the adverse effects of climate change on agricultural productivity and rural livelihoods. This agroforestry practice also provides habitat for beneficial organisms and natural pollinators like birds, honey bees, butterflies and other beneficial soil microbes. This agroforestry practice also helps in crop diversification, soil amendment, control of harmful pathogens and extension of cropping season. So, the respondents of the study area got all the benefits including environmental, social, economic and biological simultaneously from this kind of agroforestry practice. Almost similar finds were reported by [22, 41, 42, 43] in their respective studies on agroforestry practices for sustainable and resilient agricultural development.

4.5 Factors Influencing Native Date Palm Based Agroforestry Practice

There are a number of underlying reasons responsible for the gradual decline of interest in date palm based agroforestry practice. From the discussion with farmers, it was found that lack of expert individual who is commonly called as *gachi* (collector of date juice) and to

conduct intercultural practices makes it difficult to manage the date palms. Another notable constraint is lack of availability of good quality planting materials in the study area. Besides, cultivation of high value crops like malta, dragon, guava, mango, jujube, lemon etc. becomes popular day by day due to increasing demand of the consumers. Due to undeveloped marketing facilities and lack of food processing industries, farmers are bound to sell their products (e.g. palm sap, fruit etc.) at a low market price that causes significant economic loss. Last but not the least, unavailability of high yielding date palm varieties, lack of technical knowledge of rural farmers about cultivation technique and management procedure of date palm trees are the major constraints faced by farmers of the study area. Similar problems were also identified by [21, 24] in their respective studies.

5. CONCLUSION

Native date palm (*Phoenix sylvestris*) based agroforestry is a common practice in Chaugachha upazila (sub-district) under Jessore district of Bangladesh. It is evident that native date palm (*Phoenix sylvestris)* based agroforestry practice has significant contributions to improve the livelihood of rural farmers in the south western zone of Bangladesh. Due to having multipurpose uses, date palm based agroforestry practice improved the livelihood of rural farmers to a moderate (47%) to high (32%) extent. Despite having multidimensional advantages, farmers are facing a wide range of constraints in practicing this agroforestry system. Most of the farmers apply traditional knowledge in case of cultivation and management practices of date palm based agroforestry due to lack of improved knowledge and skills. The policy implication from our study suggests that linkage between research, extension and technical advisory service providing organizations should be more strengthen to make this agroforestry practice economically viable. The Department of Agricultural Extension (DAE) and Department of Forestry (DoF) should work collaboratively with non-government organizations (NGOs) to conduct need based participatory training and skill development programs for rural farmers on improved

agroforestry management practices. Emphasis should be given to raise mass awareness about the beneficial impacts of date palm based agroforestry practice including conservation of natural ecosystem to mitigate adverse effects of climate change.

Consent

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

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