COMPARISON OF DIFFERENT DATE PALM BASED AGROFORESTRY SYSTEMS AT RAJOIR UPAZILLA OF MADARIPUR DISTRICT

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CERTIFICATE

This is to certify that the thesis entitled ***'COMPARISON OF DIFFERENT DATE PALM BASED AGROFORESTRY SYSTEMS AT RAJOIR UPAZILLA OF MADARIPUR DISTRICT'*** *submitted to the faculty of Agriculture, Sher-e-Bangla Agricultural University (SAU), Dhaka, in partial fulfillment of the requirements for the degree of* ***Master of Science (MS)*** *in* ***Agroforestry and Environmental Science*** *, embodies the result of a piece of bonafide research work carried out by* ***Ankan Halder****, Registration number:* ***13-05715,*** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that any help or source of information, received during the course of this investigation has duly been acknowledged.

Dated: JUNE, 2020
Dhaka, Bangladesh

Dr. Nazmun Naher
Professor
Supervisor

Dedicated To
My
Beloved Parents

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ABSTRACT

Date palm tree is an important component of Agroforestry system in our country. Date palm based Agroforestry system practiced by the farmer's of the Rajoir upazilla of Madaripur district were surveyed to identify and characterize the different types of Date palm based Agroforestry systems and to evaluate the economic potential as well as economic impact of these systems and to find the most suitable Date palm based Agroforestry system in this area. For these purpose four unions and 80 respondents were selected from the Rajoir upazilla of Madaripur district. Data were collected from December 2018 to January 2020 following purposive random sampling technique and analysis was done by SPSS 10 software. From the study area 6 types of Date palm based Agroforestry system were identified and among these systems the highest net return (78170 Tk./ha) can be obtained from the Date palm-jute based Agroforestry system but the highest (1.97) benefit cost ratio can be obtained from the Date palm-mustard based Agroforestry system as the production cost of mustard is lower in proportion to the jute. So, in this region Date palm-mustard based Agroforestry system is the most suitable Agroforestry system. The farmers of Rajoir upazila of Madaripur district were practicing Date palm based Agroforestry system 76.85% of their total cultivated land and were getting 77.21% cash of their total income. The relationship between the selected characteristics of the respondent farmer with their income from Date palm based Agroforestry system was found highly significant and positive. Planned cultivation procedure and technical support from extension personnel can make this system more profitable.

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LIST OF ABBREVIATIONS AND ACRONYMS

BBS - Bangladesh Bureau of Statistics
ICRAF - International Centre for Research in Agroforestry
MRF - Makiling Forest Reserve
VFFP - Village and Farm Forestry Project
SAAO - Sub Assistant Agricultural Officer
DAE - Department of Agricultural Extension
SPSS - Statistical Package for the Social Sciences
Wt. - Weight
% - Percentage
e.g. – *Exempli gratia* (by way of example)
et al. - And others
g- Gram
kg - Kilogram
i.e. - *Edest* (means that is)
ha. - Hectare
Tk. – Taka
BCR – Benefit Cost Ratio
SDC – Swiss Agency for Development and Co-operation
df - Degrees of freedom

CHAPTER Ⅰ

INTRODUCTION

Agroforestry is an age-old and ancient practices and an integral part of the traditional farming system in Bangladesh. It is a sustainable land management system which increases the over all yield of the land, combines the production of crops (including tree crops) and forest plants and/or animals simultaneously or sequentially on the same unit of land and applies management practices that are compatible with the cultural practices of local people. Bangladesh is one of the overcrowded countries having 164.6 million populations spread over 147570 Sq km with an increasing growth rate of 1.37% (BBS, 2018). These increasing population demand rising at a geometric rate for food, shelter, fuel etc. and increasing per capita consumption. As a result, the gap between actual demand and supply of product is jumping day by day. As the gap between demand and supply of fuel wood for domestic cooking is wide, the balance comes almost entirely from village sources such as tree, crop residues and animal dung (Byron, 2004), which are traditional sources of farmland manure. On the other hand, it is said that a country needs 25% forest coverage to maintain its ecological balance. But in the last statistics it was observed that we have only 148.39 lakh hectare land in which forest covers only 17.35% area (BBS, 2018) which is very much limited beyond the requirement. So the large demand of food and fuel has created a tremendous pressure on the reserved forest for instance reserve forest depleted by 61% between the years 1983 to 2003 (Chowdhury and Hossain, 2005).

Agroforestry as a new applied science is a matter of discussion of the contemporary time with the increase of human being in the geometrical progression while the land area remaining infinite, there is no other alternative but to grow food, fuel, fodder and fiber in an integrated manner in the same unit of land. In Bangladesh, rice is cultivated in 80% of the total agricultural land. Farmers never allow plant tree in rice field because of their misbelieveness that shade is harmful for rice. But farmers must take the newly applied Agroforestry

technology if the trees possess qualities like less shaded, hard pruning tolerable, less dispersing, deep rooted and less competable to nutrient, water and sunlight. The Agroforestry practice increases yield and services per unit area. Assuming sustainability of the area more yield is expected from the different combinations. If there will be failure in one crop due to natural disasters, the other crop would supplement the deficit. Services like soil protection, amelioration of the micro-climate, colorful scenery, shelter belts etc. also can be obtained by this technology. Date palm based system is one of the renowned types of cropland Agroforestry systems (Abedin and Quddus, 1992). The Date palm (*Phoenix sylvestris*) is grown in Bangladesh where juice is the primary economic product of which extraction starts from the 5^{th} or 6^{th} year after planting or emergence of the tree. Date palm juice contain water 19.00%, ash 2.20%, protein 1.70%, fat 1.90% (ether extract) and reducing sugars as invert sugar 73.5% (Cleveland and Fellers, 2012). Date palm juice produces more quality gur (sugar plates) than sugarcane and may be an alternative source of sugar to supplement the increased demand of sugar, which may create a great positive impact in sugar economy of Bangladesh.

Date palm is an evergreen plant so it plays a vital role in environmental and ecological balance. It helps to mitigate natural disaster. It also acts as a barrier against storm, cyclone, and other natural calamities. It also withstands both waterlogged condition and drought. The leaves can be chopped and mix with straw to use as feed for the cattle during flood time. A significant amount of sugar uses can be reduced by the substitution of gur. Moreover, Date palm is also an important source of fuel for household. Recently it is widely used in brick-kilns. There is a great use for mat making and building material and in other handicrafts manufacturing. It also acts as insurance to the farmers during the time of their economic hardship.

In addition, the Date palm also yielded a variety of products for use in agricultural production and for domestic utensils, and practically all parts of the palm had a useful purpose. A significant economic return is possible from the cultivation of

the Date palm trees. Nevertheless, in Bangladesh, very little attention has paid for the systematic cultivation of Date palm for better yield.

Madaripur is one of the districts where Date palm based Agroforestry system is practiced in a large scale by the communities. Considering the above facts, a thorough investigation has been made in the Rajoir upazila of Madaripur district with the following objectives:

i. To identify the different types of Date palm based Agroforestry systems at the study area.
ii. To determine the economic potentiality of different crops practiced with Date palm in the Date palm based Agroforestry system.
iii. To find the most suitable and beneficial Date palm based Agroforestry system.
iv. To study the economic benefit of Date palm based Agroforestry system at Rajoir upazila of Madaripur district.

CHAPTER Ⅱ

REVIEW OF LITERATURE

Date palm based Agroforestry is one of the recognized Agroforestry systems which largely practiced in Madaripur district of Bangladesh. Some of the literatures relevant to the major objectives of the present study are reviewed under the following headings.

2.1 Agroforestry system

ICRAF states that "Agroforestry is collective name for all land use systems and practices where woody perennials are deliberately grown on the same land management unit as agricultural crops or animals in time form of Spatial arrangement or temporal sequence'' (Nair, 1984).

Miah *et al*. (2001) emphasized that in Bangladesh main thrust should be on introduction of suitable Agroforestry tree species in the crop field. However, before taking any type of production plan of planting tree species on cropfield, it is very essential to know in detail about the existing major Agroforestry systems under specific location.

Rocheleau and Hock (1997) reported that in the densely settled farming community in the sub-humid mid-lands of Kenya, pathways, water courses,farm boundaries and internal borders were fully utilized for planting of appropriate trees and shrubs. Some 50 percent of the fuel wood and 40 percent of fodder requirements of the households in the area could be supplied by these hedgerows, having very little competition with existing agricultural land uses.

Asaduzzaman *et al*. (2006) conducted a study on existing Agroforestry systems of crop field and the homestead area at the farming system researchsite, Bagherpara, Jessore district, Bangladesh. The study revealed that there exist 22 horticultural and 16 forestry species in the homestead and 7 horticultural and 8 forestry species in the

crop field. Among the horticultural Species in the crop field the intensity of Date palm was highest (17.45 trees/per farm). It was shown that 5-15 percent yield of field crops reduced due to trees but this yield losses sub-situated by the fruits, juice and wood of the trees in the crop field. On an average farmer earned yearly Tk. 5093.00 per farm from the crop field trees.

It is stated that Agroforestry systems that incorporate a range of tree and crop species offer much more scope for useful management of light interception and distribution than do monoculture forests and agricultural crops. The potential benefits as a result of combining field crops with trees are so obvious from consideration of the waste nutrient resources experienced in orchards and tree crop combination (Jackson, 1997).

Lagemann (2003) opined that the cropland Agroforestry system is very important in the economy of Bangladesh. In fact, Agroforestry is a term that invariably brings up the homesteads to the forefront particularly in a country like Bangladesh.

Akter *et al*. (2008) conducted a survey in the farming system researchsite, Bagherpara, Jessore to understand the existing Agroforestry situation. The investigation revealed that Date palm, Babla, Palmyra palm and Jackfruit were grown on the croplands for fruit, fuel, timber, juice, molasses, building materials etc. It was stated that manufacture of molasses, use of fuel and mat making are the primary reasons behind Date palm cultivation. It was observed that among marginal and small farmer, income from Date palm sustains the family maintenance for 5-6 months in a year.

Saxena (1994) pointed out that proper Agroforestry utilizes the inter spaces between tree rows for intercropping with agricultural crops and this does not impair the growth and development of the tree but enable farmers to derive extra income in addition to benefits accrued from the use of fuel and timber tree.

Ong (1988) reported that intercorporating trees with arable crops could increase biomass production per unit area increased substantially when the roots of trees

exploit water and nutrients below the shallow roots of cropland when a mixed canopy intercepts more solar energy.

Akter *et al.* (2009) mentioned that farmers also consider trees as savings and insurance against risk of crop failure and low yield, as well as assets for their children. Some farmers stated that tree would contribute toward expenses for marriage of their daughters.

Ahmed *et al*. (2008) observed in their study potential plant species for both homestead and farmland of the area including Mango (*Mangifera indica*).Date palm (*Phoenix sylvestris*), palmyrapalm (*Borassus flabellifer*), Babla(*Acacia nilotica*), Eucalyptus (*Eucalyptus camaldulensis*), ipil-ipil (*Leucaena leucocephala*), and Silkoroi (*Albizia procera*). The trees in homestead may be managed on a rotation of 2-3 years to produce fuelwood. Fruit trees may be retained for longer period to obtain fruits and timber.

Hosier (1998) observed that an Agroforestry system, planners must pay attention to input and output mixes and attitudes toward risk as components of smallholder profitability. From the smallholder's perspective, local market conditions and existing practices may provide a greater indicator of project success or failure than environmental benefits, which may be nearly impossible to quantify. A positive on-farm economic analysis provides a necessary but not significant indication of the successful introduction of an Agroforestry project.

Fernandes and Nair (2000) reported that the intimate mix of diversification agricultural crops and multipurpose trees fulfils most of the fundamental needs of the total populations and their multi-storied configuration and high species diversity avoid the environmental deterioration commonly associatedwith monocultural production systems. Moreover, they have produced sustained yields for centuries in a most resource efficient way. Thus, cropland is economically efficient, ecologically sound and biologically sustainable production systems. Homestead gardens are common in Bangladesh where the farmers take up combination of 10-15 species of fruit, omamental and multipurpose trees, along with vegetables to meet their own or

aesthetic value (Rang et al.,1990).

Abedin and Quddus (1992) recognized a variety of homestead and cropland Agroforestry systems viz. *Mangifera indica* based, *Artocarpus heterophyllus* based, *Syzyzium samarangence* based, *Phoenix sylvestris* based, *Cocos nucifera* based, *Dalbergia sissoo* based etc. Basically cropland is the unit of survival for rural population for centuries and it sustained the rural population by providing enough food for families and also cash income.

Zabala (2001) reported that the most level areas where there are no problems of soil erosion and runoff, protective trees are not required and thus there is no intercropping, instead trees are planted along the border of the area. Fast growing, multipurpose trees are planted along properly borders; they are lopped off periodically for fuel wood and their leaves are also harvested and used as fodder or as green manure. In addition, normal litter-fall serves as added green fertilizer for the food crop.

Trees are grown in the cropland, homestead, orchard not only produce food,fruits, fodder, fuel wood or to generate cash for various purposes(Chowdhury and Satter, 1993) but also gives better living environment (Haque, 1996).

Pavlovsky (1999) observed that Agroforestry protected the ecology of farmlands by shelterbelt systems (including vertebrate fauna, agricultural productivity and ecology of afforested slopes, sands and grasslands shelterbelts as a source of timber the sanitary role of shelterbelts (in protecting against pollution), the aesthetic and recreational role of forest shelterbelts and design of agricultural lands oasis type reclamation of arid steppe and semi-desert by afforestation and organization of Agroforestry.

Shaikh (2006) conducted a study on the profitability of cropland Agroforestry method of cultivation vis-a-vis non-Agroforestry methods of crop cultivation. Cost benefit analysis of different cropping patterns on cropland Agroforestry method (net area 2.2 ha.) showed that the net return was Tk. 26686, asagainst a net return

of Tk. 44829 from the assumed area of the same 2.2 ha.under non-Agroforestry method. Financial analysis of cropland Agroforestry showed that benefit-cost ratio was 1.59, worth of net benetit was 291.515Tk. per year, and internal rate of retum was 19.15 percent. This studyindicated that the cropland Agroforestry method of cultivation is more profitable than non-Agroforestry method.

Hocking and Islam (2007) observed that due to pruning of shoot and root the tree yield was reduced by 41% and crop (rice, wheat, jute and pulses) yield by 7%.

Kumar *et al.* (1998) conducted a research and found that there were 3 windbreaks situated on the North, West and East sides of the crop field. Crop infection was greater near the West and South windbreaks than the North windbreak or the open part of the field. Microclimate investigations in the vicinity of the South windbreak showed lower air temperatures and light (i.e.greater shade), and greater relative humidity under the tree canopy than outside it during the day. *Alternaria* leaf blight was also recorded on *B.campestris*, but levels of this disease were not increased by the shelterbelts.

Solanki (2008) stated that Agroforestry can significantly contribute inincreasing demand of fuel wood, fodder, cash and infrastructure in many developing countries. He also stated that Agroforestry has high potential to simultaneously satisfy 3 important objectives: (i) protecting and stabilizing the ecosystems (ii) producing a high level output of economic goods (fuel, fodder, small timber, organic fertilizer etc) and (iti) providing stable employment, improved income and basic material to rural populations.

Francisco (2009) conducted to the profitability analyses of the dominant farming systems (Agroforestry system I (agricultural crops with forest/fruittrees), Agroforestry system II (mixed fruit/forest trees) and mono-perennial cropping systems) in Makiling Forest Reserve (MFR), in Philippines. He suggested that an average size of approximately two hectares can be anadequate farm size for farm households.

Basavaraju *et al*. (2000) concluded that selection of suitable tree species for Agroforestry is important. However, it is not always possible to select tree species having all the desirable characteristics for Agroforestry, because of different production and protection goals. It is stated that in such cases,Agroforestry systems have to be managed through planting optimum density of trees, proper spatial arrangement and pruning and thinning of tree crownsand roots to reduce the negative effects of trees.

Ahmed (2001) reported that Swiss Agency for Development and Co-operation (SDC) undertook a major cropland Agroforestry initiative in the North Bengal in 1996 through its Village and Farm Forestry Project (VFFP).This was an action-oriented programme aimed at promoting production innon-forest areas (cropland and homegardens). The main objectives were to generate cash, fuel wood and fodder from privately owned farmland for the subsistence and sustenance of landless, marginal and poor farmers through planting trees on cropland and homegardens.

Koirala *et al*. (2001) found that land holding size, education level and forestry extension media play an important motivational factor in varying degrees in plantation programmes in cropland Agroforestry.

Neupane *et al.* (2001) observed that practices that minimize the rate of soil degradation, increase crop yields and raise farm income are key to sustaining agricultural productivity in the hills of Nepal. They also stated that Agroforestry has great potential for enhancing food production and farmers economic conditions in a sustainable manner through its positivecontributions to household income.

Morris *et al.* (2002) found that boundary vegetation is an important resource for farmland wildlife, for biodiversity and as a landscape component. While commercial aspects generally dominated field boundary management, farmers and professionals and the wider public also appreciated hedgerows as landscape or

countryside features. The study Suggests it may be useful to build on or influence these attitudes to maintainor enhance the conservation value of field boundary vegetation.

Oiu *et al.* (2002) reported that the fields using curly willow in draws had substantially higher economic returns than the bascline. which uses agricultural crops in draws. Two alternative uses of draws (i.e. switch grassand cottonwood) had lower economic returns than the baseline for all three agricultural systems without Conservation Reserve Program payments.Three scenarios of crop price were evaluated, viz. 5, 10 and 15% simultaneous decreases in maize, soybean and wheat prices. Lower cropprices reduce the profitability of agricultural systems, thus encourage alternative uses of draws. Alternative uses of draws increase return flow an reduce surface runoff, sediment yield and nutrient/pesticide pollutants associated with runoff and sediment, such as N, P and pesticides.

Stirzaker *et al*. (2002) predicted that the success of a tree/crop mixture becomes less likely with declining crop season rainfall and increasing seasonal variability and more likely when the tree products have a direct economic benefit.

2.2 Date palm based Agroforestry system

Popenoe (2001) stated that the exact origin of the Date palm (*Phoenix dactylifera* L.) is considered lost in antiquity. However, it is certain that the Date palm was cultivated as early as 4000 B.C. since it was used for the construction of the temple of the moon god near Ur in Southern Iraq -Mesopotamia.

Mason (2005); Milne (2008) pointed that Date palm is a dioecious species with male and female flowers being produced in clusters on separate palms. These flowering clusters are produced with axils of leaves of the previous year's growth. In rare cases both pistillate and staminate flowers are produced on the same spike while the presence of hermaphrodite flowers in the inflorescence has also been reported.

Nixon and Wedding (2006) reported that an adult Date palm has approximately 100 to 125 green leaves with an annual formation of 10 to 26 new leaves. The functional value of the leaf to the palm declines with age and no two leaves are the same age. Furthermore, leaves which are four years old are only about 65 percent as efficient in photosynthesis per unit area, compared to leaves of one year old.

One kilogram of the flesh of ripe Deglet Noor dates contains the following:water (220 g), sugar (730 g; 2740 calories), proteins (22 g), Fats (2 g) and minerals (19 g,) K 6480 mg), P (630 mg), Ca (590 mg), Mg (580 mg), Fe(30 mg) and Na (10 mg)), vitamin A (500 units), vitamin B1 (0.9 mg), vitaminB2 (1 mg) and vitamin B7 (22 mg) (Genske and Weers, 2003).

Sanjoy (2009) found that the mean of income per Date palm tree per season was Tk. 135.53 and the expenditure per Date palm tree per season was Tk. 89.97.

Idris (2003) stated the importance of Date palm. He gave detailed description of this economic tree and shown the scope of cultivation, rural employment and alleviation of poverty. He stated that 5-6 members' rural families can survive from the earning of this tree alone. He also estimated that if Date palm is grown in a planned manner it is possible to run two new sugar mills and sugarcane field can be released for the cultivation of other crops.

Ahmed (2004) reported that both male and female Date palm trees give juice and gur and tapping can be started at age of 7-8 years. In this process bark and xylem cells need to be cut in V shaped and juice secretes from this wound and arrangement is made by bamboo pieces to collect juice in the earthen container and this cut is renewed to continue juice secretion. Tappingis done in winter and in a season 110-185 kg juice or 10-20 kg gur can beobtained per plant.

FAO (2002) reported that manufacture of molasses, use as fuel and mat making are the principal reasons of Date palm cultivation in Bangladesh.

Kabir (2006) found that Date palm-rose -ornamental shrubs based Agroforestry system was most economical and highest net return (3,46,674 Tk./ha) can be obtained. Farmer of Jhikargacha upazilla practicing Date palm based Agroforestry system utilized 50.88% of their total cultivable land and earned 62.72% of their total income.

Akter and Haque (2006) reported that marginal and small farmers income from Date palm sustain the family maintenance for 5-6 months in a year .

Abedin *et al*. (2007) conducted a survey to determine the distribution and uses of multipurpose trees, tree/crop interactions and the crafts/cottage industries these trees support. According to them *Acacia nilotica, A.catechu, Artocarpus heterophyllus, Phoenix sylvestris, Borassus Nlabellifer* and *Mangifera indica* were the major tree species grown on the croplands of the area for fruit, timber, fuel and building material. The trees supported different craft/cottage industries. Fuel was a common, though not primary, use of all the tree species. Uses of particular trees varied from place to place and their order of importance changed over time. Species distribution differed among regions. Tree/crop combinations and their interactions dependent more on land type, age of the trees, canopy structure and pilot location of trees rather than the type of species grown. Critical issues for future research are identified as the determination of optimum tree densities,the optimum economic age for felling, relative economic importance and improved management practices.

Zambre (2008) showed that *Phoenix sylvestris*, *Pongamia glabra*, *Ficus glomerata* and *Eugenie jambolana* were indicative of water tables at 4-10 m depth and were also indicative of water-bearing strata.

Rodgers (1999) found that the value of dry deciduous forest biomass for wildlife is often determined by the presence of moisture valley situations with permanent water sources. This paper describes such a site within the dry hill slope forests of the Sariska Tiger Reserve. The valley and spring provide water, evergreen shade

and cover, fruit and fodder resources for a wide variety of animals and birds. Plant species diversity is much higher than in the surrounding forest: floristic data are given for the hillside vegetation above Algual spring and for the riverine vegetation of the spring plot. The former is dominated by open Boswellia serrata woodland upto 13m tall, with a lower layer of *Anogeissus pendula* and some *Acacia cutechu, Bauhinia racemosa* and *Wrightia tinctoria*. The latter has three main types of vegetation: a pure *Phoenix sylvestris* stand, a mixed stand with a shrub layer(for which floristic data are given) and an open stand of relict single treeswith no shrubs.

Mandal and Mazumdar (2007) stated that fruits of *Eugenia javanica* (white and red fruits), *Syzygium jambos, S. cuminij (S. cumini), Carissa carandas,Phyllanthus acidus. Phoenix svivestris, Grewia subinaequalis* and *Euphoria longan (Dimocarpus longan*) growing in the southern part of West Bengal were analyzed for weight, specific gravity, length and percentage of dry matter, total reducing and non-reducing sugars, acidity, vitamin C (Ascorbic acid) and sugars: acid ratio at their prime eating stage. Fairly high ratios of Sugars: acidity was estimated in fruits of *P. sylvestris, E. longan* and *S.jambos*. Vitamin C ranged from 0.01 to 0.06% among the species.

Ahmed *et al*. (2008) stated that Bangladesh has limited forest resources and the distribution of forests in the country is most irregular in the gangetic floodplain, Government forests are limited in greater Khulna, with small quantities in Patuakhali and Barisal. People meet their fuelwood and timber requirements from the trees growing in the homestead and cropland, and also use agricultural residues and cowdung as fuel. They also stated that potential plant species for both homestead and farmland of the area include Date palm (*Phoenix sylvestris*), palmyra palm (*Borassus flabellifer*), coconut (*Cocos nucifera*), babla (*Acacia nilotica*), eucalyptus (*Leucaena leucocephala*) and silkoroi (*Albizia procera*). The planting for farmland may be single Date palm at the centre of a plot or trees at the 4 corners of a plot and may be managed through root and branch pruning with

regular pollarding at 2-3 m height.The leaves of trees from both homesteads and farmland should be used to increase organic matter content in crop fields.

Kamaluddin *et al.* (2007) conducted a study on distribution of khejur palms (a multipurpose tree species) in the rural landscape of Bangladesh, their age gradations, tree tenure pattern, borrowing practice of palms for tapping, juice yield according to age and site, marketing pattern and income were investigated using a rapid appraisal method. Data were collected from a village in Chittagong district by categorizing farmers into 2 groups, owner and tapper, and interviewing 50 households, 25 from each group. Most of the khejur palms growing in the study area were naturally regenerating and scattered over the landscape, ranging from homesteads to roadsides, cropfields and canal banks. Palms of different age classes were present. Income from sale of fresh juice and the products derived from Juice (which include Sugar) were substantial for both owner and tapper households. Tapper households earned nearly the same as the owner households by borrowing trees for tapping. Marketing pattern, existing systems of tree tenure and the borrowing practice of trees for tapping seemed to be an effective mechanism for the fullest utilization of khejur trees.

Growth of trees and seasonal yields of understorey crops were measured by Hocking *et al.* (2002) over a five year period of four crops grown under 17 tree species at 8 x 8 m spacing in wetland rice field. All tree Species grew well in rice fields at rates comparable to their growth in forest plantations.Top and root pruning reduced average tree girths by up to 19% and average tree volume by to 41% depending on intensity of pruning. The crops monitored were *Oryza sativa, Triticum aestivum, Corchorus oletorius* and *Lens culinaris*. Crop yields under the trees averaged 93% of the corresponding yield outside tree canopy.

Islam *et al*. (2009) investigated the profitability of date (*Phoenix sylvestris*)-based Agroforestry system in selected sites of Jessore district, Bangladesh. Data were collected through an interview schedule from 60 farmers practicing date-based Agroforestry in 3 villages in Bagherpara and Sadarthana. Five major cropping

patterns were identified under date-based Agroforestry. In terms of economic viability, aus-aman-mustard pattern appeared to have the greatest potential, followed by aus-fallow-wheat, jute-aman-lentil, aus-fallow-lentil and fallow-aman-boro pattern. Date-based Agroforestry system was more profitable than without Agroforestry in each of the 5 major patterns. Intercultural budgeting for dates in Agroforestry showed higher benefit-cost ratio (3.89), a large net present value of benefit (Tk.103770) and a high internal rate of return (138%). It is concluded that date-based Agroforestry has a high profitability.

Nagarajan *et al.* (2000) stated that the distribution of available nutrients (C,N, P) were in traditional Agroforestry system with cultivated as well as uncultivated fields. *Phoenix cineraria* enhanced the C, N and P in both conditions. They also stated that the enrichment of available nutrients was significantly higher in uncultivated fields as compared to the cultivated fields.

Islam and Miah (2003) conducted a study aimed to reflect the present status of the khejur palm (*Phvenix sylvestris*) and its cultivation in the rural landscape of Chittagong district, Bangladesh. Data on the distribution of khejur in rural homesteads and marginal lands, tenural systems, age-class frequency and productivity of juice in respect to age and site, were collected and analyzed. Five sites (homestead, pond bank, canal bank, roadside and aisles of agricultural lands) were taken as representatives for khejur. In both cases of marginal lands and homesteads, owner households hold a greate rnumber of palms than the tapper households. Farmers owned 54.17% of the khejur palms growing on homesteads, aisles and pond banks and had the right to the trees and 45.83% growing along roadsides and canal banks. The highest percentage (32.53%) was found for the 7-14 years age class of the total individuals belonging to both owner and tapper groups. The average juice yield of khejur was 2.26 kg tree/tapping night.

According to Dutta and Iftekhar (2004), one of the major problems in the coastal zone of developing countries is salinity intrusion. It is increasing in those countries due to natural and anthropogenic reasons. Soil salinity is causing decline in soil

productivity and crop yield, which result in severe degradation of bio-environment and ecology. The effect of salinity on the agriculture crop is well understood even in developing countries but the effect on ecology is less explored. So in Bangladesh, a perception analysis was made on the effect of soil salinity on the homestead gardens of the worst salinity affected district Satkhira. It was found that the people have recognized salinity as a problem and construction of shrimp enclosures and maritime influence as the main reasons. Salinity increase results in reductionof crop production (2.50% per year), tree growth (2% per year) and vegetation coverage (1.87% per year). Tree species were disappearing due to salinity (three main species were *Swietenia macrophylla* > *Achras sapota* >*Spondias pinnata*). The remaining trees were affected by diseases, like top dying, leaf shedding and root rot. The main salt tolerant species are *Acacia nilotica, Cocos nucifera* and *Phoenix sylvestris.*

Arar (1997) stated that the Date palm is more salt tolerant than any other fruit crop. It will survive in soils containing 3 % soluble salts: when this content goes above 6 %, the Date palm will not grow.

Dowson (2002) compared to other plant species, the Date palm shows no damage under windy conditions. In fact, Date palm can withstand strong, hot and dusty summer wind and consequently protects the other cultures by breaking the force of the wind and sheltering more susceptible vegetation.

Pereau-Leroy (2008) stated that since the factors that favour high yield in Date palms (irmgation, fertilisation, etc.) are the same that favour the growth of the fungus, cultural techniques are not advised. However, a significant reduction in the amount of irrigation can retard the advance of infection. i.e. stopping irrigation between the months of May and October, during the hot season in the northern hemisphere.

Nixon (2014) observed al wijam disease in Al Hassa (Saudi Arabia). In Arabic, Al Wijam means poor or unfruitful. The disease is characterised by retardation in

terminal bud growth, and the whole crown of leaves formed after the occurrence of the disease have the rosetting symptoms. Newly formed leaves are reduced in size and marked by a faint narrow. Yellow longitudinal line on the midribs. Leaves become chloritic and their life spanis reduced. Death of leaves starts from the distal end and extends towards the base. Diseased spathes split open before their complete emergence and are reduced in size. The number and size of the bunches produced are also reduced year after year till the diseased palm fails to produce and dies.

Saaidi (2019) reported that the bayoud disease attacks mature and young palms alike, as well as offshoots at their base.

Black scorch disease has been observed on 17 date varieties. Thoory,Hayani, Amhat, Saidy and Halawy varieties are highly susceptible. (Djerbi, 2018a).

Djerbi (2018b) stated that brittle leaves disease, also called "Maladie desFeuilles Cassantes" in French, was first observed in Nefta, Tozeur and Degache date plantations (Tunisia) and in Adrar, M'zab and Biskra (Algeria). Both adult and young palms including offshoots are attacked alike. A broad chlorotic striping of the pinnae followed by drying of the tip of the frond is the first symptom of this disease.

CHAPTER Ⅲ

MATERIALS AND METHOD

Methodological issues followed in conducting the study have been presented in this section. The methods and operational actions followed in conducting the study. The methods used and a chronological description of the methodology followed in conducting this research work has been presented in this chapter.

3.1 General description of the study area

Rajoir Upazila of Madaripur district is situated in between 23°06' and 23°20' north latitudes and in between 89°56' and 90°06' east longitudes. It is bounded by Bhanga upazila on the north, Kotalipara and Gopalganj sadar upazilas on the south, Madaripur sadar and Shibchar upazilas on the east, Muksudpur and Gopalganj Sadar upazilas on the west.The area of Rajoir upazila is 226.62 sq km.The area is generally marked with a typical tropical monsoon climate with high temperature, considerable humidity and moderate rainfall. The minimum and maximum mean annual temperature varies from 19.09°C to 42.8°C. The mean monthly relative humidity ranges from 70% to 85%.

3.2 Selection of the study area

The study was conducted in four unions under Rajoir upazila in Madaripur district. Farmers of this area have long been practicing various Agroforestry practices, where Date palm is cultivated as main crops following agri-silvicultural practices. Farmers of this upazila grow Date palm in association with different kinds of field crops (wheat, mustard, lentil, jute, rice etc.).

Selected four unions were Khalia, Kadambari, Kabirajpur, Badarpasha under Rajoir upazila of Madaripur district which were considered for data collection.

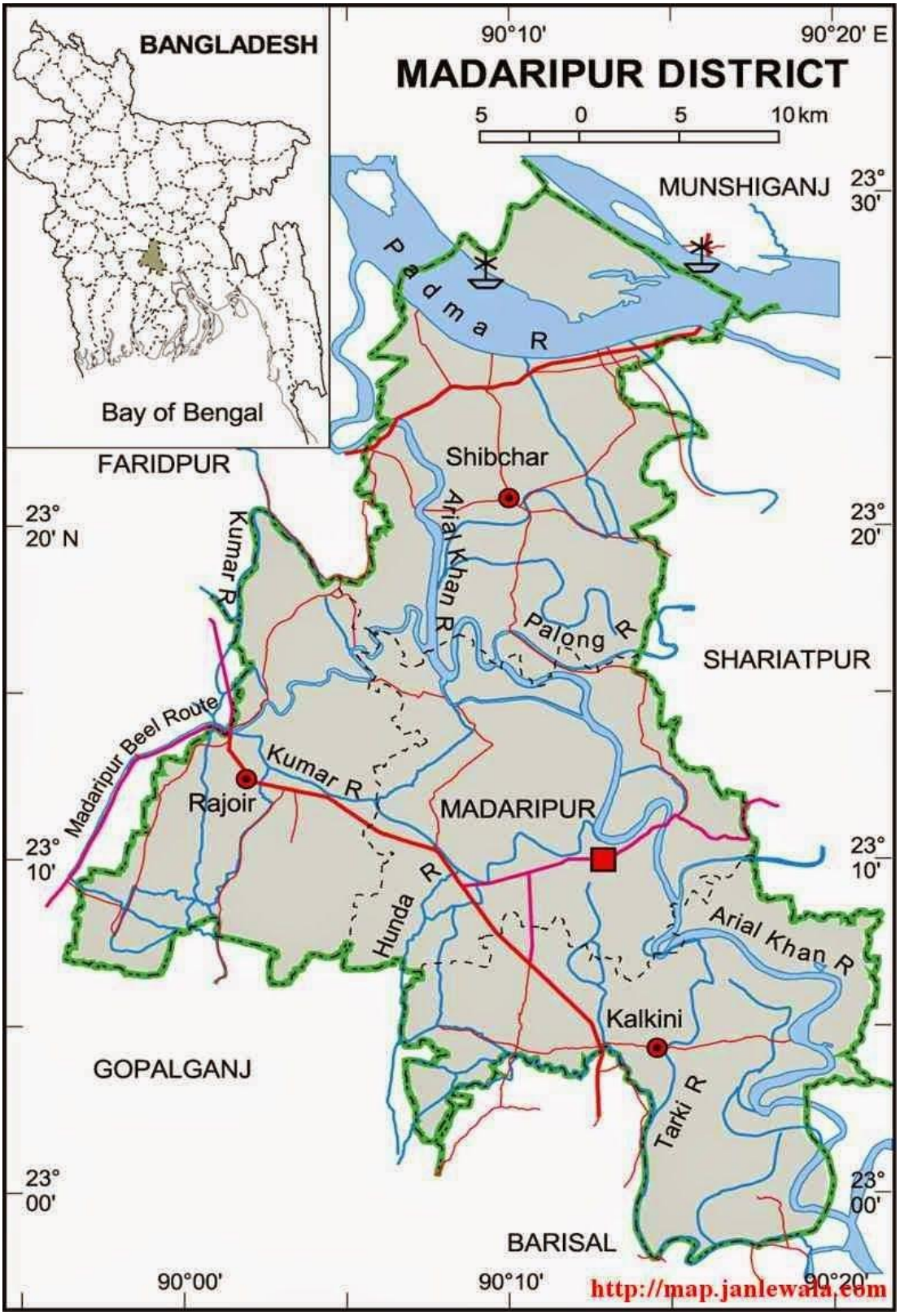

Figure 1: Map of Madaripur district

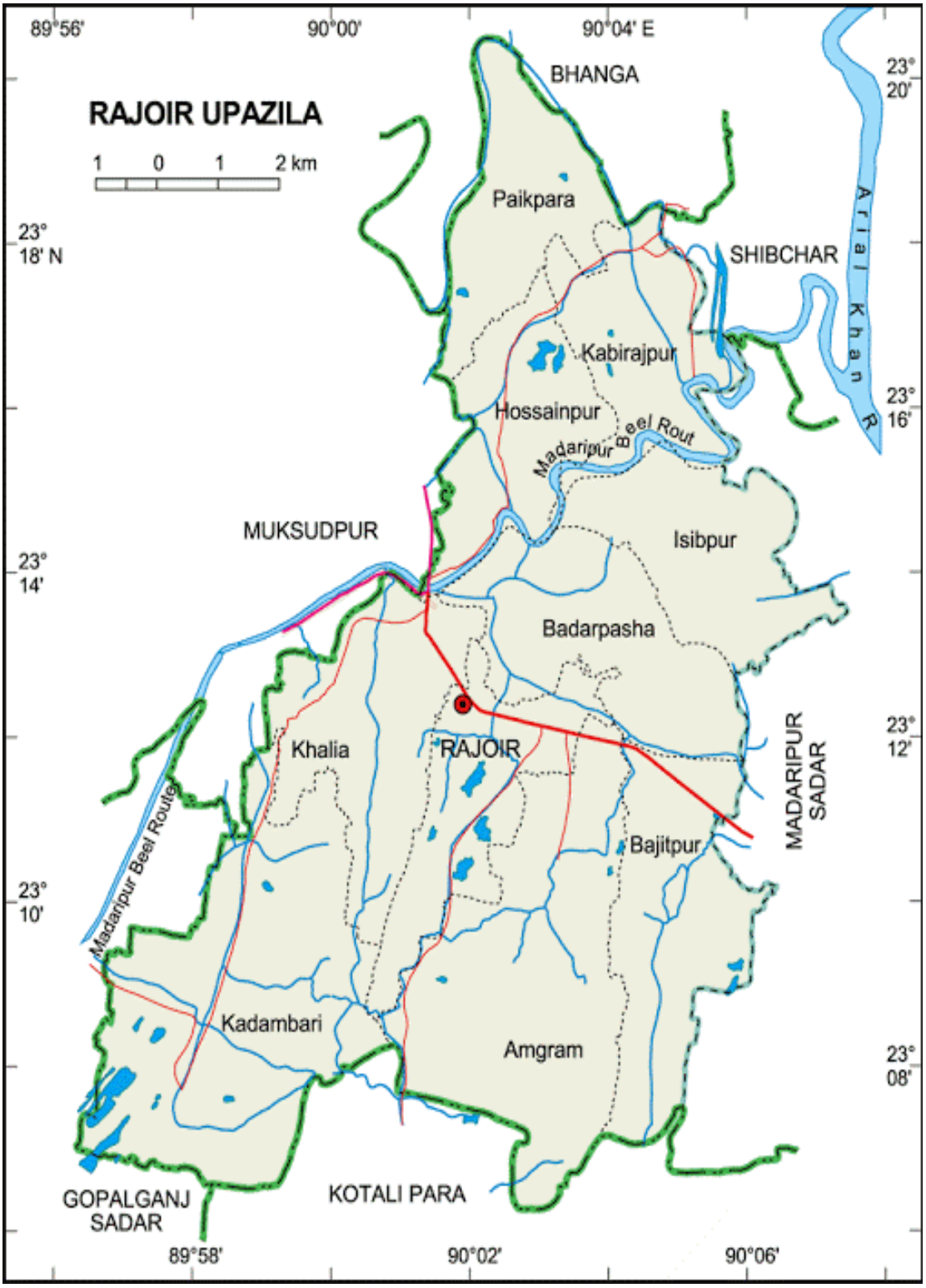

Figure 2: Map of Rajoir upazila showing study area

3.3 Population and sample

People who permanently reside in the selected areas constituted the active population of this study. As all population of the study area cannot measure, head of the farm families of the selected area was the population of the present study. However, representative sample from the population were taken for collection of data following purposive random sampling technique. One farmer (who mainly operated the farming activities of the family) from each of the farm families was considered as the respondent. An updated list of all farm family heads of the selected union was prepared with the help of Sub-Assistant Agricultural Officer (SAAO) and local leader. In particular four union of Rajoir upazilla namely, Khalia, Kadambari, Kabirajpur and Badarpasha constituted the study area. The list comprised of a total 400 farm families in the study area. These rural families constituted the population of this study. Twenty percent of the farm families of these villages were randomly selected as representative sample by using a Table of Random Numbers. Thus, 80 farm family head constituted the sample of the study. Further 20 respondent farmers were selected randomly from the population except the sample included in the reserved list, which were interviewed when the respondent in the original sample list were not available at the time of interview. A detailed structure of population and sample has been presented in the Table 1.

Table 1. Distribution of population and sample of the selected unions

Upazila	**Unions**	**Population**	**Sample**	**Reserved**
Rajoir	Khalia	90	20	5
	Kadambari	130	20	5
	Kabirajpur	100	20	5
	Badarpasha	80	20	5
Total		400	80	20

3.4 Distribution of population and sample of the selected villages

In a descriptive social research, selection and measurement of the variable is an important task. A variable is any characteristics which can assume varying or different values are successive individual's cases (Ezekiel and Fox, 1959). An organized research usually contains at least two identical elements i.e. Independent and Dependent variable. An independent variable is the factor which is manipulated by the researcher in his attempt to ascertain its relationship to an observed phenomenon. A dependent variable is the factor, which appears, disappears or varies as the experimenter introduces, removes or varies the independent variables (Townsend, 1953). According to the relevance of the research area, the researcher selected 6 characteristics of the respondents as the independent variables (e.g. age, educational qualification, family member, farm size, occupation, annual income). On the other hand income from the Date palm Agroforestry system was the dependent variable. The following sections contain procedures of measurement of dependent and independent variables of the study.

3.4.1 Measurement of independent variables

The independent variables of the study were age,educational qualification,occupation, family member, farm size and annual income .The procedure followed in measuring the independent variables have been discussed in the subsequent sections.

3.4.1.1 Age

Age of the respondents was measured in terms of actual years from their birth to the time of interview, which was found on the basis of verbal response of the rural people (Tinni, 2017). A score of one (1) was assigned for each year of one's age. This variable appears in item number one (1) in the interview schedule as presented in Appendix-A. According to their age, the respondents were classified into three categories as "young aged" (less than 40 years), "middle aged" (40 - 50 years) and "old aged" (above 50 years).

3.4.1.2 Educational qualification

Education was measured by assigning score against successful years of schooling by a respondent. One score was given for passing each level in an educational institution. For example if a respondent passed the final examination of class five or equivalent examination, his education score was given five (5). Each illiterate respondent was given a score of zero (0). A person not knowing reading or writing but being able to sign only was given a score of 0.5. This variable appears in item number two (2) in the interview schedule as presented in Appendix-A. On the basis of their level of education, the farmers were classified into five categories as Illiterate, Can sign only, Primary, Secondary, higher secondary and graduate with basic category of 0, 0.5, 1-5, 6-10 and 12 and 15 respectively.

3.4.1.3 Family size

The family size was measured by the total number of members in the family of a respondent. The family members included family head and other dependent members like husband/wife, brother and sister, parents, children etc. who lived and ate together. The total number of family members was considered as his family size score. If a respondent had five members in his/her family, his/her family size score was given as five (5). This variable appears in item number three (3) in the interview schedule as presented in Appendix-A. Based on the family size the respondents were classified into three categories as small, medium and large family as Up 5, 5 to 10 and >10 respectively.

3.4.1.4 Farm size

Farm size of a respondent was measured in terms of land area occupied by agricultural practice. Based on their farm size, the farmers were classified into three categories followed as Small, Medium and Large with the range of up to 1 , 1.05 - 1.88, above 1.88 ha respectively.

3.4.1.5 Annual income

Annual Income was measured by the sum of all income sources of a farmer from agricultural land in a year (agricultural income like framing, cropping etc. and non-agricultural income like business, service, saving, labour, other etc. A score of 1 (one) was given for each thousand Taka. On the basis of annual family income from Agroforestry, the farmers were categorized into three classes namely low, medium and high income categorieswith the ranges between up to 50,000, 50,500 – 1,50,000 and above 1,50,000 respectively.

3.4.1.6 Occupation

Occupation of a respondent was measured in terms of working by him and respondent to the time of interview. It was operationally measured in terms of actual occupation. On the basis of their occupation they are classified as agriculture, business and service and others which were calculated with given score of 1, 2,3 and 4 respectively.

3.4.2 Measurement of dependent variable:

The dependent variable in this study was the income from Date palm based Agroforestry system.

3.4 Hypothesis

A null hypothesis states that there is no relationship between the concerned variable. If a null hypothesis is rejected on the basis of statistical test, it is concluded that there is a relationship between the concerned variables. However, following null hypotheses was formulated for the present study:

“There was no relationship between the selected characteristics of the respondents and income from Date palm based Agroforestry system”

The selected characteristics are: farm size, total cultivated land and Date palm based cultivated land.

3.5 Collection of data

Data were collected by the researcher himself during December 2018 to January 2020. To get valid pertinent information, the researcher made all possible efforts to explain the purpose of the study to the respondents. Interviews were conducted with the respondents in their homes and farms. While staring interview with respondent, the researcher look all possible care to establish rapport with him/her so that she/he did not feel hesitant or hesitate. The questions were clearly explained wherever any respondent felt difficulty in understanding properly. The Sub-Assistant Agricultural Officer (SAAO), Agricultural officer, DAE rendered good cooperation in arranging appointments with the respondents.

3.6 Compilation of data

After completion of field survey data from all the interview schedules were compiled, tabulated and analyzed according to the objectives of the study. In this process, all the responses in the interview schedule were given numerical coded values. Local units were converted into standard units. The responses to the questions in the interview schedules were transferred to a master sheet to facilitate tabulation. Tabulations and cross tabulations were done on the basis of categories developed by the investigator himself.

3.7 Statistical Analysis of data

The data were coded and tabulated for the purpose of analysis.The analysis was performed using statistical treatment with SPSS computer package programme. Descriptive analysis such as range, frequency number and percentages, mean standard deviation and rank order were used wherever possible. Pearson's product moment correlation coefficient (r) was used in order to explore the relationship between the concerned variables. Throughout the study, five percent (0.05) and one percent (.01) level of probability was used as a basis for rejecting the null hypothesis. Cost of production of different Date palm based Agroforestry system was also estimated to evaluate the best Date palm based Agroforestry system .

CHAPTER Ⅳ

RESULTS AND DISCUSSION

In this chapter the findings of the study and their interpretations are presented. This chapter deals with the individual characteristics of the participants, condition of Date palm cultivation, the relationships between the selected characteristics of the participants and their status of Date palm cultivation, cost of production of different Date palm based Agroforestry systems and comparison of different Date palm based Agroforestry systems.

4.1 Individual characteristics of the respondents:

In this section the findings of the participants' individual characteristics have been discussed.

4.1.1: Age

Age of the respondents ranged from 38 to 78 years. The average age is 55.71. On the basis of range of age, the participants were classified into three categories as shown in Table 2.

Table 2. Distribution of the respondents according to their age

Characteristics	Category	Range		Mean	Frequency	Respondent %
		Minimum	Maximum			
Age (years)	<40	38	78	55.71	10	12.5
	40-50				36	45
	>50				34	42.5

Data presented in table 2 indicate that the highest proportion (45 %) of the respondents fell in the age category of 40-50 years, 12.5% fell below 40 years and 42.5% were above 50 years old.

4.1.2 Education

Education of a respondent was measured by the level of his formal education i.e. highest grade (class) passed by him. The education score of the respondents ranged from 0 to 15. The average is 5.6. Based on education, the participants were classified into four categories as shown in table 3.

Table 3. Distribution of respondents according to their education

Characteristics	Category	Range		Mean	Frequency	Respondent %
		Minimum	Maximum			
Education	Illiterate	0	15	5.6	12	15
	Can sign only				32	40
	Primary education(1-5)				12	15
	Secondary education(6-10)				10	12.5
	Higher secondary education(12)				8	10
	Graduate(15)				6	7.5

Among the respondents, 15% were illiterate, 40.0% can sign only, 15% completed primary education, 12.5% completed secondary education, 10 % completed higher secondary education and 7.5 % were graduate.

4.1.3 Family size

The family member of the respondents varied from 2 to 13 with an average of 7.13. Based on the number of family members, the respondents were divided into three categories such as small, medium and large in the table 4.

Table 4. Distribution of respondents according to their family size

Characteristics	Category	Range		Mean	Frequency	Respondent %
		Minimum	Maximum			
Family size (No. of people)	Small family (up to 5)	2	13	7.13	25	31.25
	Medium family (5-10)				49	61.25
	Large family (above 10)				6	7.5

Data presented in the table 4 indicate that 61.25 percent of the respondents belonged to the "medium family" category compared to 31.25 percent who belonged to small family category and 7.5 percent to "large family" category.

4.1.4 Farm size

Farm size of the respondents varied from 0.097 to 5.12 hectare (ha). The average farm size was 1.53 ha. The respondents were classified into three categories, showing in the table 5.

Table 5. Distribution of respondents according to their farm size

Characteristics	Category	Range		Mean	Frequency	Respondent %
		Minimum	Maximum			
Farm size (ha.)	Small farm (up to 1 ha)	0.097	5.12	1.53	22	27.5
	Medium farm (1.05-1.88 ha)				48	60
	Large farm (above 1.88 ha)				10	12.5

Data in table 5 show that the highest proportion (60 percent) of the participants had medium farm compared to 12.5 percent had large farm and 27.5 percent having small farm.

4.1.5 Annual income

The annual income of a respondent was determined by adding his income from (crop, vegetables, tree, cattle, poultry, fisheries, business, job, and other sources)

during a year. The income was expressed in Taka. The range of annual income was (Tk.30000 to 211500) with an average of Tk.78708.75. Based on annual income the respondents were divided into three categories as shown in table 6.

Table 6. Distribution of respondents according to their annual income

Characteristics	Category	Range		Mean	Frequency	Respondent %
		Minimum	Maximum			
Annual income (000 tk.)	Low income (up to 50000)	30	211.5	78.7	32	40
	Medium income (50500-150000)				38	47.5
	High income (above 150000)				10	12.5

Data shown in table 6 revealed that highest proportion 47.5 percent of the respondents had medium annual income compared to 12.5 percent as high income group and 40 percent under low income group.

4.1.6 Occupation

Most of the respondent's occupation was agriculture. Business and service holder respondents were also present. According to their occupation the respondents are classified in to the following groups as shown in table 7.

Table 7. Distribution of respondents according to their occupation

Characteristics	Category	Frequency	Respondent (%)
Occupation	Agriculture	55	68.75
	Business	10	12.5
	Service	14	17.5
	Others	1	1.25
Total		80	100

Data shown in table 7 revealed that highest proportion 68.75 percent of the respondents are involved in the occupation agriculture as compared to 17.5 percent are involved in service. 17.5 percent are leading their life through the occupation business and next 1.25 percent involved in others.

4.1.7: Area of land having Date palm based Agroforestry system

Respondents applied kinds of palm based Agroforestry system on the basis of suitability of their land as required. Respondents were categorized into three groups as shown in table 8.

Table 8. Distribution of respondents according to their area of land in which they have Date palm trees

Area of land (ha.)	Respondents	
	Frequency	Percentage (%)
>0.04	28	35
0.04-0.08	44	55
<0.08	8	10
Total	80	100

Data in table 8 show that the highest proportions (55%) of the respondents had .04 to 0.08 ha of land in which they have applied Date palm based Agroforestry system. 35 % respondents had greater than 0.04 ha where only 10% had less than 0.08 ha land applied Date palm Agroforestry system.

4.2: Types of Date palm based Agroforestry system practiced in selected area

After an extensive survey of the selected areas of Madaripur district, the following Date palm based Agroforestry practices were identified.

a) Date palm- rice based Agroforestry system
b) Date palm-jute based Agroforestry system
c) Date palm-mustard based Agroforestry system
d) Date palm-lentil based Agroforestry system
e) Date palm-sesame based Agroforestry system
f) Date palm-wheat based Agroforestry system

4.2.1: Duration of Date palm based Agroforestry system practiced

Date palm based Agroforestry system were practiced in different times. Respondents had Date palm trees in their field from different years. Some respondents applied earlier and others have followed them. Three categories of time duration had made for the respondents shown in table 9.

Table 9. Duration of Date palm Agroforestry system practiced by respondents (N =80)

Sl no.	Agroforestry systems	<10 years	10-20 years	>20 years
1	Date palm-Rice	30 (37.5)	45 (56.25)	5 (6.25)
2	Date palm-jute	25 (31.25)	35 (43.75)	20 (25)
3	Date palm-mustard	32 (40)	42 (52.5)	6 (7.5)
4	Date palm-lentil	34 (42.5)	33 (41.25)	13 (16.25)
5	Date palm-sesame	26 (32.5)	21 (26.25)	33 (41.25)
6	Date palm-wheat	30 (37.5)	40 (50)	10 (12.5)

(Figures in parenthesis are the percentages of the numbers)

The duration of practicing palm based Agroforestry system by the respondent farmers were categorized into three categories i.e. less than 10 years, 10-20 years, greater than 30 years. The findings showed that on an average of 50%, 34% and 16% respondents practice this system from 10-20 years, less than 10 and greater than 30 years, respectively. Sanjoy (2009) found that about 52%, 25%, 12% and 11% respondents practice this system from 10-20 years, less than 10 years, 20-30 years and greater than 30 years, respectively.

4.2.2: Union wise total cultivated land and Date palm based Agroforestry system practiced land of the respondents

Four union of Rajoir upazila were selected for the study. From the study area six categories of Agroforestry system have been identified. Total cultivated area and percent Date palm cultivated area had shown in table 10.

Table 10. Union wise total cultivated land and percent Date palm based Agroforestry system practiced by the respondents

Name of union	Categories of Date palm associated crops	Area of Date palm associated crops (ha.)	Total cultivated land (ha.)	Percent Date palm associated area (%)
Khalia	Date palm-Rice	8.22	30.60 (64.05)	**26.86**
	Date palm-jute	2.70		8.82
	Date palm-mustard	2.51		8.20
	Date palm-lentil	1.34		4.38
	Date palm-sesame	.71		2.32
	Date palm-wheat	4.12		16.73
Kadambari	Date palm-Rice	5.06	28.50 (74.05)	24.77
	Date palm-jute	1.59		5.57
	Date palm-mustard	7.10		**24.91**
	Date palm-lentil	2.52		8.84
	Date palm-sesame	.21		.73
	Date palm-wheat	4.95		20.88
Kabirajpur	Date palm-Rice	6.59	25.15 (88.07)	26.20
	Date palm-jute	2.52		10.02
	Date palm-mustard	3.63		14.43
	Date palm-lentil	7.45		**29.6**
	Date palm-sesame	.50		1.99
	Date palm-wheat	1.46		5.81
Badar pasha	Date palm-Rice	5.85	32.71 (87.75)	17.88
	Date palm-jute	4.34		13.27
	Date palm-mustard	3.56		10.88
	Date palm-lentil	3.02		9.23
	Date palm-sesame	1.23		3.76
	Date palm-wheat	10.71		**32.74**

(Figures in parenthesis are the union wise percentages of the Date palm based associated area**.)**

Data in the table 10 shows that the highest proportions (26.86%) of Date palm-rice based Agroforestry is practiced in Khalia union, thus the highest proportions (24.91%),(29.6%) and (32.74%) of Date palm-mustard, Date palm-lentil and Date palm-wheat based Agroforestry system are practiced in Kadambari, Kabirajpur and Badar pasha union, respectively . Area of 13.27% and 3.76% of Date palm-jute and Date palm-sesame are practiced in Badar pasha union. This table also shows that the highest total cultivated land was obtained from the respondents of Badar pasha union. Date palm-rice based Agroforestry system was practiced in 8.22 ha, 5.06 ha, 6.59 ha and 5.85 ha of land in the union of Khalia, Kadambari, Kabirajpur and Badarpasha, respectively. Date palm-jute based Agroforestry system was practiced in 2.70 ha, 1.59 ha, 2.52 ha and 4.34 ha of land in the union of Khalia, Kadambari, Kabirajpur and Badarpasha, respectively. Date palm-mustard based Agroforestry system was practiced in 2.51 ha, 7.10 ha, 3.63 ha and 3.56 ha of land in the union of Khalia, Kadambari, Kabirajpur and Badarpasha, respectively. The farmers of Khalia, Kadambari, Kabirajpur and Badarpasha union practiced Date palm-lentil based Agroforestry system in 1.34 ha, 2.52 ha, 7.47 ha and 3.02 ha of their land, respectively. The farmers of Khalia, Kadambari, Kabirajpur and Badarpasha union practiced Date palm-sesame based Agroforestry system in .71 ha, .21 ha, .50 ha and 1.23 ha of their land, respectively. Date palm-wheat based Agroforestry system was practiced in 4.12 ha, 4.95 ha, 1.46 ha and 10.71 ha of land in the union of Khalia, Kadambari, Kabirajpur and Badarpasha, respectively.

4.2.3: Union wise annual income and income from practicing Date palm based Agroforestry systems.

The annual income of a respondent was determined by adding his income from (crop, vegetables, tree, cattle, poultry, fisheries, business, job, and other sources) during a year. The income was expressed in Taka. Income from different Date palm based Agroforestry system was tabulated and percent income from Date palm based system to total income was calculated. Table 11. shows the income percent.

Table 11. Union wise total income and percent income from Date palm based Agroforestry system of the respondents

Name of union	Categories of Date palm associated crops	Income from Date palm associated crops(Tk.)	Total income(Tk.)	Percent income from Date palm associated crops %
Khalia	Date palm-Rice	313520	1572000 (79.04)	18.34
	Date palm-jute	211059		26.14
	Date palm-mustard	170511.8		16.55
	Date palm-lentil	75145		9.11
	Date palm-sesame	25755.9		3.47
	Date palm-wheat	277679.8		**26.40**
Kadambari	Date palm-Rice	198301.4	1432543 (82.05)	12.55
	Date palm-jute	124290.3		13.93
	Date palm-mustard	482324.3		**43.08**
	Date palm-lentil	141319.1		8.81
	Date palm-sesame	7624.5		2.30
	Date palm-wheat	333420.1		19.34
Kabirajpur	Date palm-Rice	179882.1	1556231 (75.45)	9.31
	Date palm-jute	196988.4		16.37
	Date palm-mustard	246596.8		17.23
	Date palm-lentil	417788.6		10.16
	Date palm-sesame	18153.5		7.31
	Date palm-wheat	98401.1		**39.62**
Badar pasha	Date palm-Rice	229261.5	1475425 (88.07)	15.76
	Date palm-jute	339257.8		12.58
	Date palm-mustard	241841.5		18
	Date palm-lentil	169358.6		**27.07**
	Date palm-sesame	44657.6		3.95
	Date palm-wheat	721832.6		22.64

(Figures in parenthesis are the union wise percentages of the income from Date palm based Agroforestry system)

Data in table 11 shows that the highest (26.40%) of total income is obtained from Date palm-wheat based Agroforestry system in Khalia union. Thus, highest proportions (43.08%),(39.62%) and (27.07%) of total income is obtained from Date palm-mustard, Date palm-wheat and Date palm-lentil based Agroforestry system in Kadambari, Kabirajpur and Badar pasha union, respectively. This table also shows that the highest total income is obtained from the respondents of Kadambari union.

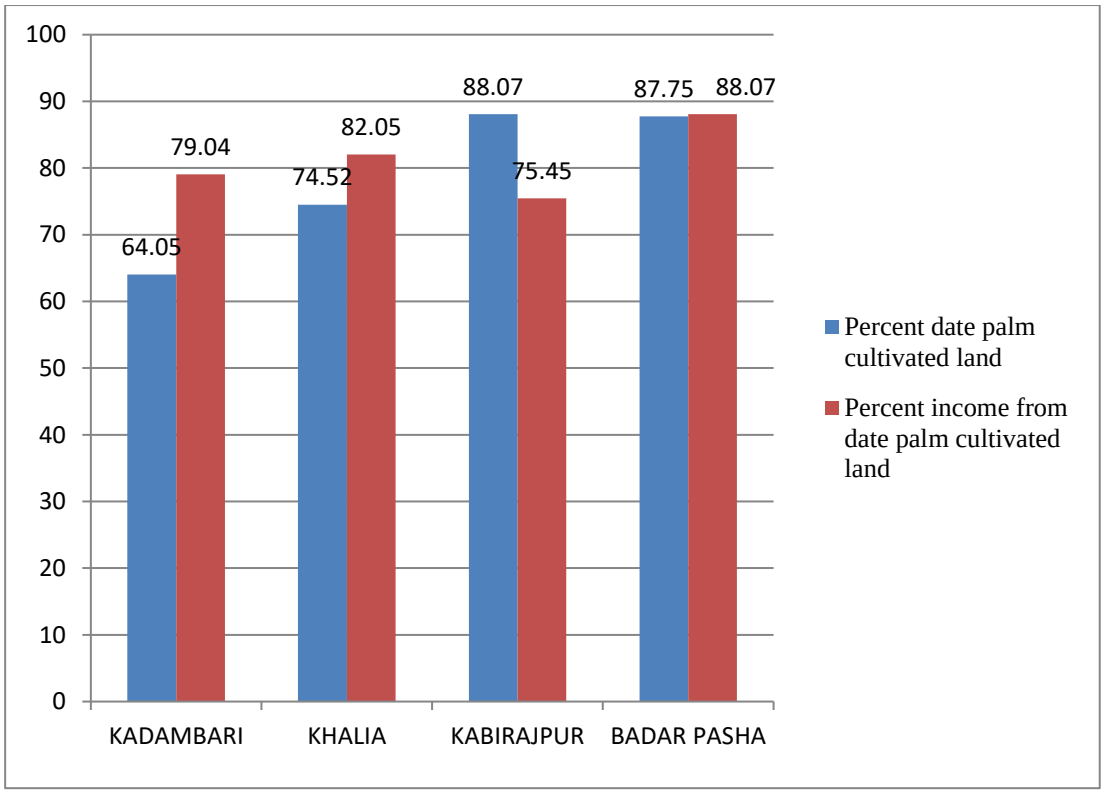

Figure 3: Union wise percent Date palm cultivated land from total land and percent income from Date palm cultivated land from total income.

Figure 3 shows that the highest (88.07 %) Date palm cultivated land was found in Kabirajpur union and the lowest (64.05 %) was found in Kadambari union. The highest (88.07) percent income from date palm cultivated land was obtained from Badarpasha union and the lowest (75.45) percent was obtained from Kabirajpur union.

4.3: General description of different Date palm based Agroforestry system

4.3.1: Date palm-Rice based Agroforestry system

Date palm trees are planted scatteredly into ails of the rice field (Plate 1). Sometimes the farmer followed spacing and design and sometimes no design is followed and the Date palm tree is planted according to the farmer's desire. Rice is usually cultivated by transplanting in this system.

This type of Agroforestry system was observed in different places of Rajoir upazill. But the highest (26.86%) of total cultivation land were practiced in Khalia union and the highest (26.40%) of total income was obtained in this union from Date palm-rice based Agroforestry system (Table 10 and 11).

Plate 1. Date palm-Rice based Agroforestry system in Khalia union .

Table 12. Cost of Production of Date palm- Rice based Agroforestry system per hectare area

a. Production Cost

Items	**Material Cost(Tk.)**	
	Date palm	**Rice**
Planting material cost		1500
Fertilizer cost		8600
Pesticide application cost		500
Instrument cost	100	500
Items	**Non-material Cost(Tk.)**	
	Date palm	**Rice**
Land preparation cost		16800
Intercultural operation cost	500	8000
Labor cost	250	9000
Harvesting cost		12000
Marketing cost		1500
Fixed cost		18510
Total cost	850	77210
Grand total	**78060**	

b. Gross Return/Output:

Items	**Date palm**	**Rice**
Sell price		103500
Own consumption	1000	12750
Total income	1000+116250=117250	

c. Benefit Cost Ratio:

$$\textbf{Benefit Cost Ratio (BCR)} = \frac{\text{Gross Income}}{\text{Total Cost of Production}} = \frac{117250}{78060}$$

$$= \mathbf{1.50}$$

4.3.2: Date palm-Jute based Agroforestry system

In many villages of Badar pasha union of Rajoir upazila, farmers are practicing this type of plantation. In such plantation Date palm trees are usually planted as a boundary plantation along the common ail (bund) of two different farmers at a distance of 7 to 9 m. The farmers owing the field are cultivating jute by broadcasting (Plate 2). Farmers of Badar pasha union are practicing this system 13.27% of their total cultivated land and getting 12.58% of their total income from cultivated land (Table 10 and 11). But the highest (26.14%) of total income is obtained by the farmer of Khalia union.

This farming system has resemblance with the production system practiced in the sub-humid mid-lands of Kenya farm boundaries where internal borders were fully utilized for planting of fuel wood and fodder requirements of the households (Rocheleau and Hock, 1997).

Plate 2. Date palm-Jute based Agroforestry system in Badar pasha union

Table 13 . Cost of Production of Date palm- Jute based Agroforestry system per hectare area

a. Production Cost

Items	**Material Cost(Tk.)**	
	Date palm	**Jute**
Planting material cost		700
Fertilizer cost		13990
Pesticide application cost		1000
Instrument cost	150	500
Items	**Non-material Cost(Tk.)**	
	Date palm	**Jute**
Land preparation cost		21000
Intercultural operation cost	550	17500
Labor cost	250	20500
Harvesting cost		40500
Marketing cost		3000
Fixed cost		23715
Total cost	950	142405
Grand total	143355	

b. Gross Return/Output:

Items	**Date palm**	**Jute**
Sell price		218000
Own consumption	1525	2000
Total income	**221525**	

c. Benefit Cost Ratio :

$$\textbf{Benefit Cost Ratio (BCR)} = \frac{\text{Gross Income}}{\text{Total Cost 0f Production}} = \frac{221525}{143355}$$

$$= \mathbf{1.55}$$

4.3.3: Date palm-Mustard based Agroforestry system

Farmers of Kadambari union of Rajoir upazila are planting Date palm tree at a distance of 8 to 9 m along ails (bound) of the field. Mustard is sown with broadcast method as an annual winter crop (Plate 3). About 24.91% of the total cultivated land of Kadambari union is covered with this system and 43.08% of the total income is coming from it (Table 10 and 11). Highest benefit cost ratio (1.97) is obtained by this Agroforestry system.

Similar study was done in Jessore district and the Date palm-mustard Agroforestry system gained the highest benefit cost ratio (Kabir, 2006).

Farmers are usually using this system because Date palm are stress tolerable multipurpose tree and are heavy prunable. This study was similar to Zabala (2001).

Plate 3 . Date palm-Mustard based Agroforestry system in Kadambari union

Table 14. Cost of Production of Date palm- Mustard based Agroforestry system per hectare

a. Production Cost

Items	**Material Cost(Tk.)**	
	Date palm	**Mustard**
Planting material cost		1000
Fertilizer cost		15030
Pesticide application cost		1000
Instrument cost	750	500
Items	**Non-material Cost(Tk.)**	
	Date palm	**Mustard**
Land preparation cost		6250
Intercultural operation cost	1255	4500
Labor cost	1360	1500
Harvesting cost	2450	11750
Marketing cost	5255	1000
Fixed cost		16500
Total cost	11070	59030
Grand total	70100	

b. Gross Return/Output:

Items	**Date palm**	**Mustard**
Sell price	22575	102000
Own consumption	3458	10000
Total income	26033+112000=138033	

c. Benefit Cost Ratio :

$$\textbf{Benefit Cost Ratio (BCR)} = \frac{\text{Gross Income}}{\text{Total Cost of Production}} = \frac{138033}{70100}$$

$$= \mathbf{1.97}$$

4.3.4: Date palm-Lentil based Agroforestry system

In Kabirajpur union of Rajoir upazila, farmers scatteredly planted Date palm in the open field without considering any recommended spacing. The cultivated winter crop was lentil in this land (Plate 4). The farmers are earning 10.16% of total income from 29.6% of total cultivated land which are covered with Date palm-lentil based Agroforestry system (Table 10 and 11). The highest income percent (27.07) of total income was obtained by the farmer of of Badar pasha union. (Table 1) . Kabir (2006) also conduct a similar survey in Jessore district founding similar result from Date palm lentil based Agroforestry system.

In the present survey it was found that farmers of Kabirajpur union are fully utilizing this system for fuel, gur and fodder requirements. Rocheleau and Hock (1997) also described a similar practiced that observed in Kenya.

Plate 4 . Date palm-Lentil based Agroforestry system in Kabirajpur union

Table 15 . Cost of Production of Date palm- Lentil based Agroforestry system per hectare area

a. Production Cost

Items	**Material Cost(Tk.)**	
	Date palm	**Lentil**
Planting material cost		3000
Fertilizer cost	125	9200
Pesticide application cost		500
Instrument cost	840	500
Items	**Non-material Cost(Tk.)**	
	Date palm	**Lentil**
Land preparation cost		8250
Intercultural operation cost	1378	3250
Labor cost	1250	1500
Harvesting cost	2245	5000
Marketing cost	5326	1000
Fixed cost		16965
Total cost	11164	49165
Grand total	60329	

b. Gross Return/Output:

Items	**Date palm**	**Lentil**
Sell price	21458	90500
Own consumption	3250	1200
Total income	24708+91700= 116408	

c. Benefit Cost Ratio :

$$\textbf{Benefit Cost Ratio (BCR)} = \frac{\text{Gross Income}}{\text{Total Cost of Production}} = \frac{116408}{60329}$$

$$= \mathbf{1.93}$$

4.3.5: Date palm-Sesame based Agroforestry system

In this system of Agroforestry, Date palm trees are planted in the ail (bound) of the field as a windbreak or shelterbelt. Sesame seeds are planted through broadcasting method. As, the production of sesame is low a small quantity of farmers apply this system in their field where they have to produce sesame for oil purpose. Farmers of Badar pasha union of Rajoir upazila are practicing this system about 3.76% of the total cultivated land and getting more benefit (about 3.95% of the total income) than mono cropping system (Table 10 and 11).But the highest (7.31%) of total income was obtained by the farmers of Kabirajpur union(Table 11).

According to Bhuiyan (1997), this model needs intensive care and attention and it can be a highly beneficial system to the farmers. Therefore, it will be a highly profitable Agroforestry practices for that region.

Plate 5. Date palm-Sesame based Agroforestry system in Badar pasha union

Table 16 . Cost of Production of Date palm- Sesame based Agroforestry system per hectare area

a. Production Cost

Items	**Material Cost (Tk.)**	
	Date palm	**Sesame**
Planting material cost		1050
Fertilizer cost		6450
Pesticide application cost		1500
Instrument cost	128	500
Items	**Non-material Cost (Tk.)**	
	Date palm	**Sesame**
Land preparation cost		6650
Intercultural operation cost	570	3200
Labor cost	350	2850
Harvesting cost		7250
Marketing cost		500
Fixed cost		15750
Total cost	1048	45700
Grand total	46748	

b. Gross Return/Output:

Items	**Date palm**	**Sesame**
Sell price		76805
Own consumption	1250	5000
Total income	1250+81805 =83055	

c. Benefit Cost Ratio :

$$\textbf{Benefit Cost Ratio (BCR)} = \frac{\text{Gross Income}}{\text{Total Cost of Production}} = \frac{83055}{46748}$$

$$= \mathbf{1.78}$$

4.3.6: Date palm-Wheat based Agroforestry system

Date palms are grown in the crop field in scattered way in the selected areas usually maintaining 9 m spacing at different design. Sometimes the farmers did not follow any design and spacing. As a result, trees are grown as the farmers desired suitable in the crop field. The annual crops cultivated in such field by the farmers are wheat (Plate 6). Wheat is usually cultivated by broadcast method.

This type of Date palm based Agroforestry system was observed in the present study in many places of Badar pashaunion of Rajoir upazila of Jessore district. They are practicing this system about 32.74% of their total cultivated land and getting 22.64% of total income (Table 10 and 11).But the highest (39.62%) of total income was obtained by the farmers of Kabirajpur union (Table 11). Kabir (2006) reported that Date palm-wheat Agroforestry system is one of the most popular Date palm based system practiced in Bangladesh.

Plain land Agroforestry modules allowed this system, because crown could be beaten down by heavy pruning and root competition is minimized by root pruning through circular trenches around tree base (Bhuiyan, 1997).

Plate 6. Date palm-Wheat based Agroforestry system in Badar pasha union

Table 17. Cost of Production of Date palm- Wheat based Agroforestry system per hectare area

a. Production Cost

Items	**Material Cost (Tk.)**	
	Date palm	**Wheat**
Planting material cost		3900
Fertilizer cost	90	9700
Pesticide application cost		500
Instrument cost	720	500
Items	**Non-material Cost (Tk.)**	
	Date palm	**Wheat**
Land preparation cost		12500
Intercultural operation cost	1340	4250
Labor cost	1143	2250
Harvesting cost	4568	9750
Marketing cost	3689	1500
Fixed cost		18150
Total cost	11550	68000
Grand total	74550	

b. Gross Return/Output:

Items	**Date palm**	**Wheat**
Sell price	24605	104475
Own consumption	1468	11400
Total income	26073+115875=141948	

c. Benefit Cost Ratio :

$$\textbf{Benefit Cost Ratio (BCR)} = \frac{\text{Gross Income}}{\text{Total Cost of Production}} = \frac{141948}{74550}$$

$$= \mathbf{1.90}$$

4.4: Comparison of different Date palm based Agroforestry systems

Table 18. Cost and return analysis of different Date palm based Agroforestry system

Sl no.	Date palm based Agroforestry system	Gross income (Tk./ha)	Total cost of production (Tk./ha)	Net income (Tk./ha)	BCR
1	Date palm-Rice	117250	78060	39190	1.50
2	Date palm-jute	221525	143355	78170	1.55
3	Date palm-mustard	138033	70100	67933	**1.97**
4	Date palm-lentil	116408	60329	56079	1.93
5	Date palm-sesame	83055	46748	36307	1.78
6	Date palm-wheat	141948	74550	67398	1.90

Data in the table 18 shows that highest cost of production (143355) is obtained in case of Date palm-jute based Agroforestry system and highest gross income(221525) and highest net return (78170) can be obtained from this system. The lowest cost of production (46748) is needed in case of Date palm-sesame based Agroforestry system and the net income is also lowest (36307) in this system.

Benefit cost ratio is the amount we use and the amount we get as return. If we arrange the value of benefit cost ratio (BCR) get in table 18 from higher to lower (1.97 >1.93>1.90>1.78>1.55>1.50), we will see the most profitable Date palm based Agroforestry system. So, the highest benefit cost ratio is obtained from Date palm-mustard based Agroforestry system. It means that if, a farmer invest 1 taka in Date palm-mustard Agroforestry system in an unit land, he will get 1.97 taka as a return from it.

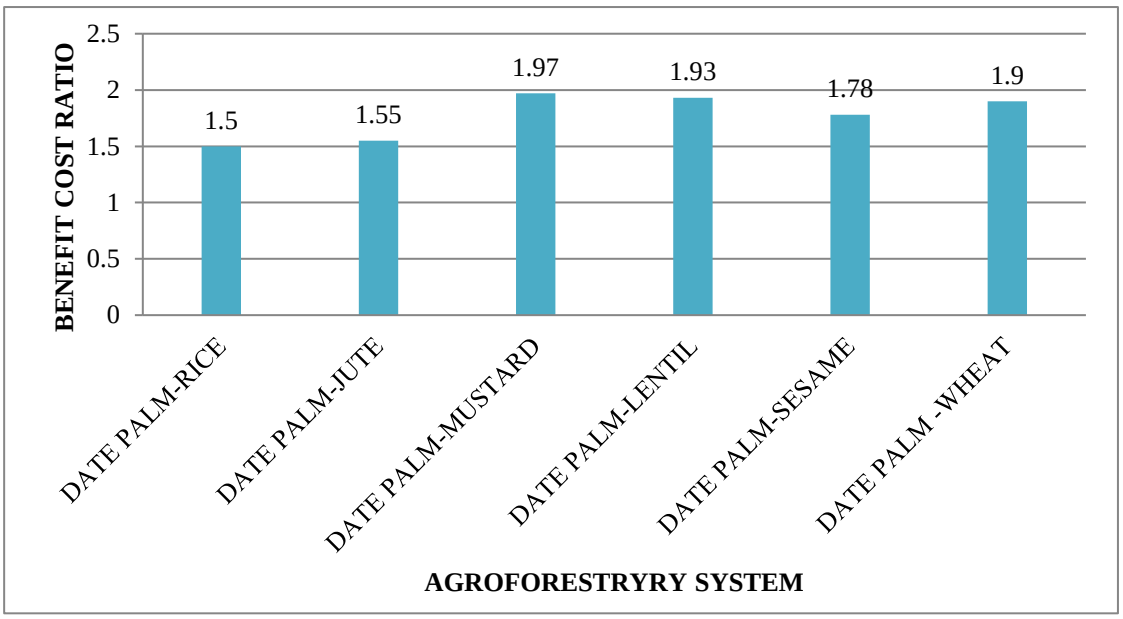

Figure 4. Benefit cost ratio of different Agroforestry system in Rajoir upazilla of Madaripur district (obtained from table 18).

4.5: Economic benefit from Date palm based Agroforestry system

Data were collected from four union of Rajoir upazila of Jessore district. Randomly selected 20 respondent from each union as a total 80 respondent was interviewed through similar questionnaires. An English version of the questionnaire is given in Appendix I. From the compiled data in Appendix II, it was found that people of Rajoir upazilla were practicing Date palm based Agroforestry system about 76.85% of their total cultivated land and earning 77.21% cash of their total income from total cultivated land. Earning cash from Date palm based Agroforestry system is comparatively higher when practicing this system which is shown in figure 5 and 6.

The relationship between the selected characteristics of the respondent farmers and their income, correlation co-efficient ‘r’ has been determined and presented in Table 19.

Table 19. Correlation between selected characteristics of respondents with their income from Date palm based Agroforestry system

Dependent variables	Independent variables	Tabulated value at 79 df		Values of coefficient of correlation
		0.05 level	**0.01 level**	
Income of the respondents	Farm size	0.217	0.283	0.797**
	Total cultivated land			0.799**
	Date palm based Agroforestry system practiced land			0.916**

****** Correlation is significant at 0.01 and 0.05 level .

The co-efficient of correlation (r) between the concerned variables was computed and found to be 0.797, 0.799 and 0.916. Computed value and tabulated value of "r" was presented in the table 19. The computed value of "r" (0.797, 0.799 and 0.916) was found to be greater than the tabulated value of "r" (0.217) with 79 degrees of freedom at 1% level of probability. The null hypothesis was rejected. The coefficient of correlation between the concerned variable was significant at 1% and 5% level of probability. The finding implies that farm size, cultivated land, Date palm based Agroforestry system practiced land had significant positive relationship with their income from Date palm based Agroforestry system.

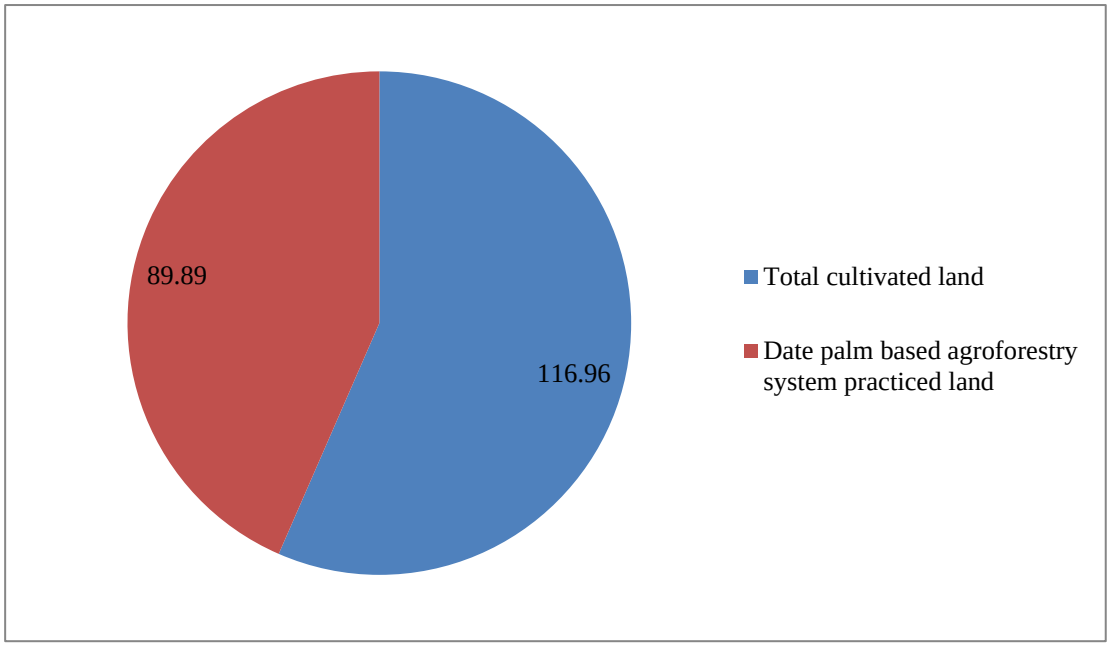

Figure 5. pie chart showing total cultivated land and Date palm based Agroforestry system practiced land

Pie chart shows that, the total cultivated land was 116.96 ha and the Date palm based Agroforestry system practiced area was 89.89 ha in the study area.

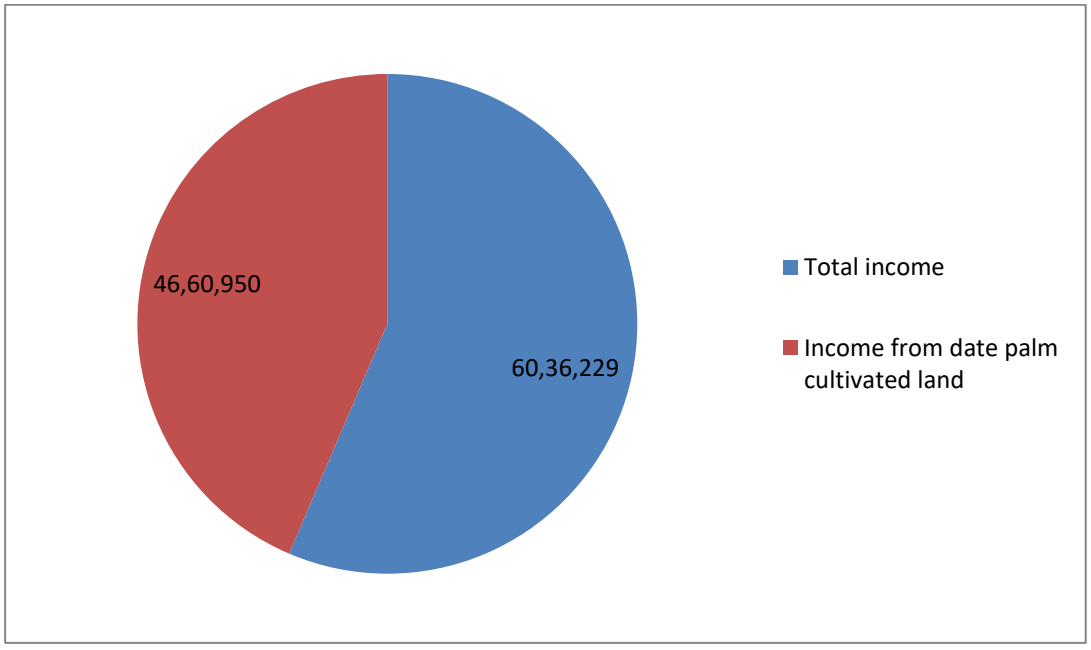

Figure 6. Pie chart showing total income and and income from Date palm based cultivated land.

Pie chart shows that total income of the respondents was 60,36,229 taka and the income from Date palm based cultivated land was 46,60,950 taka in the study area.

CHAPTER Ⅴ

SUMMARY AND CONCLUSIONS

SUMMARY

An attempt has been taken in Rajoir upazila of Madaripur district to observe the different Date palm based Agroforestry system practiced by the farmers with a view to identify and characterize the different Date palm based Agroforestry practices, to identify the best Date palm best Agroforestry system and also to determine the economic potential as well as economic impact of those practices usually followed by the farmers. For these purposes four union of Rajoir upazilla of Madaripur district were selected. The selected areas were visited frequently from December 2018 to January 2020. Pre-tested questionnaire were used for the survey during visit, in which a total of 80 respondent farmers were interviewed. Data were collected following purposive random sampling technique and analysis was done by SPSS 10 software. About 45% farmers were between the age of 40-50, 42.5% farmers were greater than 50 years old and 12.5% farmers were below 40 years old. About 40% farmers can sign only, 15% illiterate, 15% completed primary school, 12.5% completed secondary education and 7.5% farmers were graduate. About 62.25% respondents belonged to the medium family (5-10 members), 31.25% to the small family and 7.5% belonged to the large family. Highest 60% farmers had medium farm size (1.05-1.88), 27.5% had small farm size (up to 1 ha.), 12.5 % farmer had large farm (above 1.88 ha.). About 47.5% farmers had medium income (50,500-1,50,000), 40% farmers had low income (up to 50,000) and 12.5 % farmers had high income (above 1,50,000). About 68.75% respondents occupation were agriculture, 12.5% were business and 17.5% were service. About 55% respondents had 0.04-0.08 ha of land in which they have practiced Date palm based Agroforestry system. On an average 50% respondents practice Date palm based Agroforestry system from 10-20 years. Total cultivated land of Khalia, Kadambari, Kabirajpur and Badarpasha were 30.60, 28.50, 25.15 and 32.71 ha respectively and the percent Date palm based associated area were 64.5%, 74.05%, 88.07% and 87.75% respectively.

Total income of the respondents from Khalia, Kadambari, Kabirajpur and Badarpasha union were 15,72,000, 14,32,543, 15,56,231 and 14,75,425 Taka respectively and the percent income of the total taka from Date palm based Agroforestry system were 79.04%, 82.05% , 75.455 and 88.07% respectively. Highest net income (78170 Taka) was obtained from Date palm-Jute based Agroforestry system. The benefit cost ratio of Date palm-Rice, Date palm-Jute, Date palm-Mustard, Date palm-Lentil, Date palm-Sesame and Date palm-Wheat were 1.50, 1.55, 1.97, 1.93, 1.78 and 1.90 respectively. So, Date palm- Mustard based Agroforestry system is the most suitable Agroforestry system found in the study area. The relationship between farm size, cultivated land and Date palm based Agroforestry system practiced land with income was found highly significant and positive.

CONCLUSIONS

Based on the findings of the study the following conclusions were drawn:

1. After an investigation over a year, several Date palm based Agroforestry seytems were identified from the study area, they were Date palm- rice, Date palm-jute, Date palm-mustard, Date palm-lentil, Date palm-sesame, Date palm-wheat, Date palm-tomato, Date palm-potato and Date palm-cabbage. Among all of these Agroforestry systems six mainly practiced systems were studied in details.
2. From the study Date palm- jute based Agroforestry system was found most economical in case of net return. From this system highest gross income (221525 Tk./ha) and net return (78170 Tk./ha) can be obtained. In case of benefit cost ratio (BCR), the highest benefit cost ratio (1.97) can be obtained from Date palm-mustard based Agroforestry system. The farmer of Kadambari union practice Date palm–mustard based Agroforestry system 24.91% of their total cultivated land and get 43.08% of their total income.
3. As the production cost of jute is higher than the production cost of mustard in proportion to their net return, the benefit cost ratio value of Date palm-jute based system is lower than the Date palm-mustard system. So, the most suitable Date palm based Agroforestry system is Date palm-mustard based Agroforestry system.
4. From the economic point of view, it was observed that the farmers of Rajoir upazila of Madaripur district were practicing Date palm based Agroforestry system 76.85% of their total cultivated land and were getting 77.21% cash of their total income. The relationship between the selected characteristics of the respondent farmer with their income from Date palm based Agroforestry system was found highly significant and positive.

CHAPTER VI

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CHAPTER Ⅶ

APPENDICES

Appendix 1. Questionnaire of The Study

(English Version of the Interview Schedule)

Department of Agroforestry and Environmental Science

SHER-E-BANGLA AGRICULTURAL UNIVERSITY

Dhaka-1207

Questionnaire on

COMPARISON OF DATE PALM BASED AGROFORESTRY SYSTEM AT RAJOIR UPAZILLA OF MADARIPUR DISTRICT

A. Personal Details

Identification of the Respondent:

Name:
……..
Fathers name:
……..
Mothers name:
……...
Village:
……...
Upazilla:
……
District:
……....
Age:
……

Educational level: No education / can onlysign / Primary / SSC / HSC / Above HSC

Family status: Single/Combined

Number of Household members: Male:……Female: ……

Are you a member of anylocal organization? Yes/No

Duration of membership:……and

Name :…….

B. LocationDetails:

Soil:

i. Fertility level:L/M/H

ii. Soil Type:Sandy/Loamy/Sandy-loamy/Clay

Land Type: Hilly/Plain/Lowland/Other

C. Detail history and purpose of Cultivation:

1**.** From when and how have you related with Date palm Agroforestry system ?

2. Why do you choose Date palm Agroforestry system in your crop land?

iii. Own occupation

iv. Sale/Business

v. Both

vi. Traditionally

3. Total cultivated land area …….acre/hectare/bigha/katha.

4. Land area under Date palm based Agroforestry system ……..
acre/hectare/bigha/katha.

5. What is the age of Date palm tree ?.....years

6. How long have you been practicingDate palm Agroforestry system ?

…….Years

7. Which crop do you prefer to cultivate with Date palm?.....

8. Why you will choose this crop ?

9. Which location that you prefer to collect the associated crops?.....

10. Which season do you prefer for Date palm base based agroforesrty system ?

Rabi/Kharif

11. When it is more profitable ?

Rabi/ Kharif

12. Please mention the management practice for associated crops in Date palm based Agroforestry system

Type of work	Frequency of work	Time of work	Reasons of work

Cost of Production and Net income:

Items	**Material Cost (Tk.)**	
	Date palm	**Wheat**
Planting material cost		
Fertilizer cost		
Pesticide application cost		
Instrument cost		
Items	**Non-material Cost (Tk.)**	
	Date palm	**Wheat**
Land preparation cost		
Intercultural operation cost		
Labor cost		
Harvesting cost		
Marketing cost		
Fixed cost		
Total cost		
Grand total		

b. Gross Return/Output:

Items	**Date palm**	**Wheat**
Sell price		
Own consumption		
Total income		

(Thank You for Your Cooperation)

Signature:……... **Date:……**

Appendix 2. Distribution of Respondents According To Age, Education, Family Size, Annual Income And Occupation

Characteristics	Category	Range		Mean	Frequency	Respondent %
		Minimum	Maximum			
Age (years)	<40 40-50 >50	38	78	55.71	10 36 34	12.5 45 42.5
Education(years)	Illiterate Can sign only Primary education(1-5) Secondary education(6-10) Higher secondary education(12) Graduate(15)	0	15	5.6	12 32 12 10 8 6	15 40 15 12.5 10 7.5
Family size(No. of people)	Small family(up to 5) Medium family(5-10) Large family(above 10)	2	13	7.13	25 49 6	31.25 61.25 7.5
Farm size (ha.)	Small farm(up to 1 ha) Medium farm (1.05-1.88 ha) Large farm (above 1.88 ha)	0.097	5.12	1.53	22 48 10	27.5 60 12.5
Annual income (000 tk.)	Low income (up to 50000) Medium income (50500-150000) High income (above 150000)	30	211.5	78.70	32 38 10	40 47.5 12.5
Occupation	Agriculture Business Service Others				55 10 14 1	68.75 12.5 17.5 1.25

Appendix 3. Some Photographs Related to The Study

Plate 7. Data collection from farmer in Kadambari union

Plate 8 : Data collection from farmer in Khalia union

Plate 9. Data collection from farmer in Badar pasha union

Plate 10 : A field of Date palm-Rice based Agroforestry system

Appendix 4. Union wise date palm associated crops, covered area and total cultivated land of 80 respondents

Name of union	Res. no.	Name of crop associated with date palm	Area of date palm associated crops (ha.)	Area of individual system (ha.)	Total cultivated land (ha.)	Uni. wise t. land (ha.)
Khalia	1	Rice	2.10	8.22	3.20	30.60
	2	Rice	1.80		2.10	
	3	Rice	2.20		4.70	
	4	Rice	2.12		2.20	
	5	Jute	1.50	2.70	1.80	
	6	Jute	0.70		1.00	
	7	Jute	0.50		1.00	
	8	Mustard	0.51	2.51	0.92	
	9	Mustard	0.40		0.82	
	10	Mustard	1.00		1.16	
	11	Mustard	0.60		1.30	
	12	Lentil	0.34	1.34	0.80	
	13	Lentil	0.45		0.95	
	14	Lentil	0.55		1.05	
	15	Sesame	0.31	0.71	1.15	
	16	Sesame	0.40		1.10	
	17	Wheat	1.20	4.12	2.15	
	18	Wheat	0.80		1.25	
	19	Wheat	1.12		1.75	
	20	Wheat	1.00		1.20	
Kadambari	1	Rice	1.04	5.06	1.75	28.50
	2	Rice	2.02		3.25	
	3	Rice	0.75		1.15	
	4	Rice	0.25		1.00	
	5	Jute	0.59	1.59	0.75	
	6	Jute	0.45		0.85	
	7	Jute	0.55		0.75	
	8	Mustard	2.10	7.10	3.00	
	9	Mustard	1.75		2.25	
	10	Mustard	1.00		1.75	
	11	Mustard	1.25		2.25	
	12	Lentil	0.52	2.52	1.00	
	13	Lentil	0.60		1.25	
	14	Lentil	0.40		0.75	
	15	Sesame	0.11	0.21	0.57	
	16	Sesame	0.10		0.43	
	17	Wheat	1.25	4.95	1.55	
	18	Wheat	1.50		2.00	
	19	Wheat	1.00		1.00	
	20	Wheat	1.20		1.30	

Kabirajpur	1	Rice	1.59	6.59	1.70	25.15
	2	Rice	2.50		2.85	
	3	Rice	1.50		1.55	
	4	Rice	1.00		1.05	
	5	Jute	0.52	2.52	0.85	
	6	Jute	0.45		0.75	
	7	Jute	0.55		0.92	
	8	Mustard	0.75	3.63	1.00	
	9	Mustard	1.63		1.80	
	10	Mustard	1.00		1.20	
	11	Mustard	0.25		0.25	
	12	Lentil	1.40	7.45	1.50	
	13	Lentil	2.05		2.10	
	14	Lentil	1.75		1.80	
	15	Lentil	2.25		2.60	
	16	Sesame	0.23	0.50	0.50	
	17	Sesame	0.27		0.50	
	18	Wheat	0.45	1.46	0.55	
	19	Wheat	0.61		0.75	
	20	Wheat	0.40		0.70	
Badar pasha	1	Rice	2.45	5.85	2.71	32.71
	2	Rice	2.40		2.50	
	3	Rice	1.00		1.50	
	4	Jute	1.33	4.34	1.50	
	5	Jute	1.00		1.15	
	6	Jute	.76		1.00	
	7	Jute	1.25		1.50	
	8	Mustard	2.00	3.56	2.10	
	9	Mustard	0.56		0.65	
	10	Mustard	0.25		0.35	
	11	Mustard	0.75		0.90	
	12	Lentil	1.02	3.02	1.25	
	13	Lentil	0.85		1.00	
	14	Lentil	1.15		1.25	
	15	Sesame	1.03	1.23	1.25	
	16	Sesame	0.20		0.25	
	17	Wheat	2.51	10.71	2.75	
	18	Wheat	3.25		3.50	
	19	Wheat	2.75		3.00	
	20	Wheat	2.20		2.55	

Appendix 5. Union wise income from date palm associated crops , income from individual system and total income of 80 respondents

Name of union	Res. no.	Name of crop associated with date palm	Income from date palm associated crops (Tk.)	Income from individual system (Tk.)	Total income (Tk.)	Uni. Wise total income (Tk.)
Khalia	1	Rice	90,520	3,13,520	1,30,000	15,72,000
	2	Rice	60,000		90,000	
	3	Rice	95,000		1,70,000	
	4	Rice	68,000		90,000	
	5	Jute	1,00,069	2,11,059	1,30,000	
	6	Jute	60,500		80,500	
	7	Jute	50,500		10,500	
	8	Mustard	32,300.5	1,70,511.8	60,300.5	
	9	Mustard	28,000		55,500	
	10	Mustard	68,000		92,200.5	
	11	Mustard	42,211.3		60,320	
	12	Lentil	24,000	75,145	38,350	
	13	Lentil	25,000		40,400	
	14	Lentil	26,145		35,145	
	15	Sesame	13,230.5	25,755.9	32,230	
	16	Sesame	12,525.4		18,525	
	17	Wheat	68,000	2,77,679.8	86,400	
	18	Wheat	76,600		95,450	
	19	Wheat	65,000		85,200	
	20	Wheat	68,079.8		80,300	
Kadambari	1	Rice	50,000	1,98,301.4	60,500	14,32,543
	2	Rice	80,000		1,20,000	
	3	Rice	40,000		48,500	
	4	Rice	12,301.4		22,301	
	5	Jute	55,000	1,24,290.3	76,500	
	6	Jute	43,270		55,500	
	7	Jute	26,020.3		36,400	
	8	Mustard	1,78,000	4,82,324.3	2,10,000	
	9	Mustard	60,500		80,300	
	10	Mustard	40,324.3		58,000	
	11	Mustard	82,500		1,01,000	
	12	Lentil	41,219	1,41,319.1	55,400	
	13	Lentil	55,100		65,100	
	14	Lentil	45,000		60,180	
	15	Sesame	3,500	7,624.5	7,700	
	16	Sesame	4,124.5		8,200	
	17	Wheat	1,20,000	3,33,420.1	2,10,000	
	18	Wheat	85,420.1		1,05,000	
	19	Wheat	67,000		75,000	
	20	Wheat	75,000		95,000	

Kabirajpur	1	Rice	41,382.1	1,79,882.1	55,310	15,56,231
	2	Rice	65,500		69,400	
	3	Rice	37,500		45,300	
	4	Rice	36,000		43,700	
	5	Jute	58,988.4	1,96,988.4	70,560	
	6	Jute	60,500		74,700	
	7	Jute	70,500		80,460	
	8	Mustard	60,596.8	2,46,596.8	78,900	
	9	Mustard	86,000		1,04,800	
	10	Mustard	68,000		86,300	
	11	Mustard	32,000		43,700	
	12	Lentil	78,500	4,17,788.6	94,600	
	13	Lentil	1,13,000		1,34,500	
	14	Lentil	96,288.6		1,03,000	
	15	Lentil	1,30,000		1,50,000	
	16	Sesame	8,350.5	18,153.5	10,500	
	17	Sesame	9,802		14,800	
	18	Wheat	33,280	98,401.1	65,700	
	19	Wheat	38,162		53280	
	20	Wheat	26,959.1		45,790	
Badar pasha	1	Rice	96,015.5	2,29,261.5	1,56,000	14,75,425
	2	Rice	94,056		1,04,000	
	3	Rice	39,190		45,700	
	4	Jute	1,03,966.1	3,39,257.8	1,22,800	
	5	Jute	78,170		90,500	
	6	Jute	59,409.2		86,400	
	7	Jute	97,112.5		1,30,800	
	8	Mustard	1,02,500	2,41,841.5	1,12,800	
	9	Mustard	32,500.5		36,500	
	10	Mustard	17,400		20,500	
	11	Mustard	56,500		60,200	
	12	Lentil	66,700.6	1,69,358.6	75,800	
	13	Lentil	46,500		55,780	
	14	Lentil	56,158		66,790	
	15	Sesame	37,396.2	44,657.6	40,800	
	16	Sesame	7,261.4		8,500	
	17	Wheat	1,69,168.9	7,21,832.6	1,90,770	
	18	Wheat	2,19,043.5		2,40,000	
	19	Wheat	1,85,344.5		2,01,000	
	20	Wheat	1,48,275.7		1,70,000	