STATUS OF FISH DRYING IN TWO UPAZILAS OF SYLHET

A Thesis

By

Sabiha Sultana Marine

Examination Roll No. 1202030601, Reg. No. 0574

Session: 2007-2008, Semester: July- December/2012

Submitted to the

Department of Fisheries Technology and Quality Control

Faculty of Fisheries

Sylhet Agricultural University, Sylhet-3100

In partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

in

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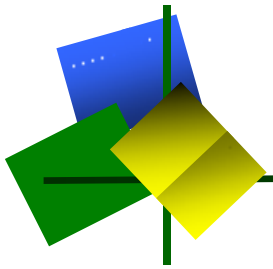

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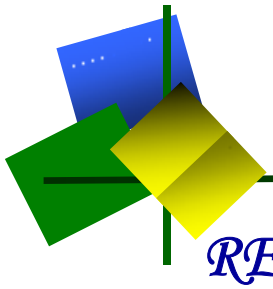

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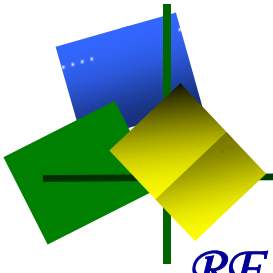

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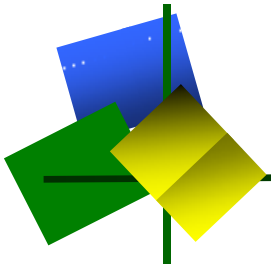

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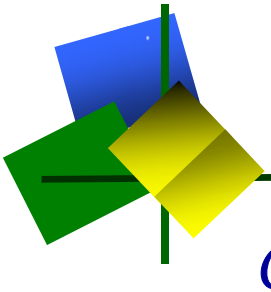

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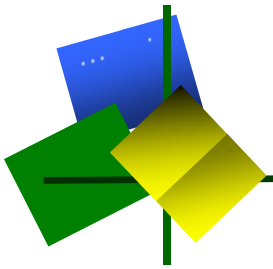

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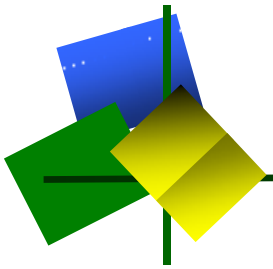

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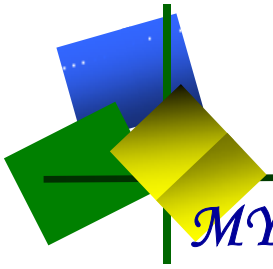

DEDICATED TO

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The Author

ABSTRACT

The present study investigates traditional process of fish drying in three representative fish drying areas in Sylhet district such as Tuker Bazar, Mahtabpur and Amtoli during October 2012 to March 2013. A total of 20 dried fish processors, selected randomly from three sites (6 from Tuker Bazar, 8 from Mahtabpur and 6 from Amtoli), were interviewed using a semi-structured questionnaire. Results show that in all sites all together 23 species of fish were used for drying purpose and most of them were smaller in size. Drying activities generally starts from October 2012 to March 2013. Traditional sun drying method was applied to process the fish. Raw fishes were collected from nearest fish markets or adjacent *haors* and transported to fish drying points mainly by non-mechanized vans and other local vehicles or shoulder. Fish processors were found doing a pre-treatment of salt before sun drying. The rate of mixing salt in the study area was found as 1kg salt for 8-10 kg of raw fish. After 5-7 hours, the fishes were washed by river, pond or *haor* water for the removal of salt. At normal weather, the drying duration was recorded as 2-6 days depending on the size of the raw fishes. Plastic, jute-made bags and sometimes bamboo baskets were used for easy handling and packaging purposes. A substantial amount of income was found to be generated from the fish drying activities as reported by the respondents where 26.31%, 28.94% and 44.73% dried fish processors were found in the income ranges of Tk. 10,000-75,000, 1,00,000-5,00,000 and 6,00,000-10,00,000 respectively. The mean area of drying yards at Tuker Bazar, Mahtabpur and Amtoli were 32.80±2.78, 34.00±4.06 and 14.9±2.30 decimal, whereas the average manpower were used 8.6±2.40, 13.4±4.67 and 5.4±1.82 persons. The mean production per yards at Tuker Bazar, Madhabpur and Amtoli were 47120±13969.50, 63600± 16009.37 and 9260±3440.64 kg respectively against mean raw material 117440±39058.52, 165500±38503.25 and 23200±9549.87 kg and mean cost 200000± 101980.39, 328000±127749.75 and 25160±8776.56 Tk. A remarkable number of male and female workers were involved themselves in fish processing activities. The mean daily wages of male and female labors were Tk. 220±78.74 and 70±12.82 respectively seems gulf of difference apparently. This study reveals that the fish processors in the studied areas mainly used the traditional methods for drying the fish and substantial improvement was needed at different stages of handling, processing, and transportation of the fresh fish to get the high quality dried fish products. Training of the fish processors on above aspects including hygiene, sanitation, good water quality and raw materials was found very important to ensure high quality dried products for the consumers.

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LIST OF ABBREVIATIONS

SYMBOL	PARAMETER
Tk.	Taka
g	Gram
Kg	Kilogram
L	Liter
Dec.	Decimal
MT	Metric ton
GDP	Gross Domestic Production

CHAPTER ONE

INTRODUCTION

Fish and fisheries are the integral part of Bangladeshi people from the time immemorial. Bangladesh is blessed with diversified fisheries resources. Bangladesh aquatic ecosystems are of three types on the basis of salinity: freshwater, brackish water and marine. Accordingly, distinct environment, ecology and population structure are noticed among them. In consideration of regional topography, brackish water and freshwater ecosystems are taken together under inland while marine ecosystem is kept separate as marine. Inland ecosystem is again of two types: closed and open in consideration of flow of water. The ecosystems vary in extent, location and importance. Inland ecosystem includes ponds, oxbow lakes, shrimp farms (closed); rivers and estuaries, *beels*, the Kaptai Lake, floodplains and polders/enclosures (open). The marine ecosystem covers territorial water (up to 12 nautical miles from the shore line), exclusive economic zone (200 nautical miles from the shore line), continental shelf (up to 40 fathom depth) and coast line. Altogether the area of this inland water is about 4.69 million hectors. Among these it contains an area of 4.04 hectors including river, *beel*, canal, *haor, baor* etc.

The Bay of Bengal is situated in the South of Bangladesh. There is a total of 1.66 million sq. km. water area including Exclusive Economic Zone (EEZ). Fishing is only confined within 200-meter depth. About 162 trawlers, 45,689 mechanized and non-mechanized boats are engaged in fishing (DoF, 2013). Pelagic and deep-sea resources are still untapped. In the year 2011-12 total fish production from Marine source was 5.78 lakh metric tons (MT). Recently, Bangladesh has got the right to access 1.00 lakh sq. kilometre water area in Bay of Bengal through International Tribunal for the Law of the Sea (ITLOS). A research vessel is under process of procurement to conduct appropriate stock assessment.

Aquatic biodiversity can be defined as the variety of life forms and the ecosystems that make up the freshwater, tidal, and marine regions of the world and their interactions. Freshwater biodiversity encompasses freshwater ecosystems, including lakes, ponds, and reservoirs, rivers and streams, groundwater and wetlands. The banks of streams or riparian areas are also important areas associated with freshwater systems. Bangladesh is rich in terms of globally important wetland ecosystem and associated aquatic biodiversity. These land water habitats from the largest floodplains in Asia (Ganges/Brahmaputra), widely considered being one of the most important wetland complexes in the world. Therefore, at

least half of the country can be considered a huge seasonal wetland subjected to periodic flooding and containing a complex array of inter-connected habitats and ecosystems. The entire system (i.e. more than half of the country) is widely accepted as a wetland of international importance under the Ramsar definition. These ecosystems include rivers, estuaries, seasonally inundated wetlands (*beels* and *haors*), lakes and *baors* (oxbow lakes). There are more than 50 semi-permanent freshwater wetlands that have been identified as wetlands of international importance; because of the periodic flooding and their hydrological characteristics, however, these sites cannot be viewed as isolated habits for conservation purposes and must be viewed as part of this entire dynamic system. Aquatic ecosystems in Bangladesh are, therefore, part of a vast floodplain whose characteristics are determined by periodic flooding and its biodiversity is highly adapted to these ecological characteristics. Most species show complex life cycles, which include elaborate migration patterns, high fecundity, high mortality, and strong dispersal characteristics.

Bangladesh is enriched with aquatic diversity containing 260 species of freshwater finfish (belonging to 12 orders, 52 families and 158 genera). The country has other aquatic resources like 50 species of reptiles, 24 species of aquatic mammals, 19 species of amphibians, 63 species of palaeomonid and penaeid prawns (Rahman, 1989; Ali, 1991; World Bank, 1991; Hossain *et. al.,* 2008), 25 species of edible tortoise and turtles, and 17 species of crabs, freshwater mussels, and snails. Moreover, 25 exotic fish species also contributed and diversified total fishery resources of the country.

The most aquatic diversity in Bangladesh depends on the intricate ecological relations produced by annual flooding on a very large scale and hydrological relations between the habitats described above. The inland aquatic habitats of Bangladesh are rich in faunal diversity containing at least 260 species of finfish, 60 species of prawn and shrimp, several species of turtles, tortoises, freshwater mussels and other living aquatic organisms (Rahman, 2005).

Although fish biodiversity has been degraded due to many reasons such as over fishing, aquaculture practice, exotic species, habitat loss and degradation, sedimentation, pollution, alterations to hydrology, dredging etc. thus the availability of our indigenous freshwater fish species have declined to a great extent over the years and many of them are either rare or at the verge of extinction. But still now we have had a remarkable amount of fish production from a vast area of our natural water bodies. We have a great variety of small indigenous species of fish (SIS). Most of the smaller sized fishes do not undertake a long

distance breeding migration. They move short distances laterally into shallow water areas for breeding. Many of them live in inundated floodplain, *beels* and marshes and breed in the monsoon season.

The fish production from three categories of major fisheries resources are-Inland Capture (34%), Inland Culture (48%), and Marine Capture (18%). Inland captures comprises of rivers, ponds, estuaries, *beels*, floodplains, *haors, baors,* brackish water etc (DoF, 2012). There are 260 fish and 24 prawn species in inland fresh water in the country. In early sixties inland fisheries contributed about 90% of total fish production of the country. Fish production from aquaculture has increased to a great extent but open water fish production is in slow progress. Now only about 34% of total fish production comes from inland open water.

In 2011-12 the total fish production is 32.62 lakh MT (DoF, 2013). Average annual growth rate of fish production in last 4 years is 6.22%. The Production from closed water bodies is increasing very sharply due to dissemination of adaptive technologies and need-based extension services.

Last 6 years fish production is shown in the following table:

Table 1.1: Last 6 years production of fish in Bangladesh

Year	Source-wise production (MT)			Total
	Inland open	Closed	Marine	
2011-2012	9,57,095	17,26,067	5,78,620	32,61,782
2010-2011	10,54,585	14,60,769	5,46,333	30,61,687
2009-2010	10,29,937	13,51,979	5,17,282	28,99,198
2008-2009	11,23,925	10,62,801	5,14,644	27,01,370
2007-2008	10,60,181	10,05,542	4,97,573	25,63,296
2006-2007	1,00,67,761	9,55,812	4,87,438	24,40,011

Fisheries sector plays a vital role in food security and economic development of our country. Fisheries sector contributed 4.39% to national GDP and 22.76% to the

agricultural GDP and 2.46% to foreign exchange earnings by exporting fish products in 2011-12. Fish provides 60% of national animal protein consumption. Fisheries sector also plays an important role in rural employment generation and poverty alleviation (DoF, 2013).

Rich and biologically diverse fisheries are vital contributors to nutrition and health of people in Bangladesh (Minkin *et al*., 1997). Minkin *et al.* (1993) stated that the rural poor people consumed 50-75 species of fish, most of which are small-sized fishes such as small punti (*Puntius* spp.), mola (mola carplet), kholisha (gourami), chanda (glassy perchlet), taki (snakehead), koi (climbing perch) and small prawn belonging to the category of miscellaneous fish known as "poor people's fish". These miscellaneous fishes are the principal source of animal protein and make a major contribution to the intake of vitamins and minerals (FAP-17, 1995; Minkin *et al*., 1997).

Inland waterbodies have been supporting rich and diversified fisheries and thus these are critically important to Bangladeshi people for their food security and livelihood (Hasan, 2004). However, due to sharp decline in fish intake over the last years, we have reached a situation of protein deficiency (Table 1.2). At present, fish consumption per capita per day is only 51.89 g, whereas the actual requirement is about 56 g.

Table 1.2 Changes in average per capita fish intake in Bangladesh

	1995-96	2003-04	2006-07	2009-10	2010-11	2011-12	Requirement
Fish intake (g/capita/da)	40.0	41.2	47.19	51.89	51.89	51.89	56

Source: Modified from (Graaf *et al*., 2001; DoF, 2013)

The North-East region is blessed with a special type of inland water ecosystem called '*haor*'. A *'haor'* is a wetland ecosystem, physically a bowl or saucer shaped shallow depression, also known as a backswamp. In a country where one third of all area can be termed as wetlands, the *haor* basin is an internationally important wetland ecosystem, which is situated in Sunamganj, Habiganj and Moulvibazar districts and Sylhet Sadar Upazila, as well as Kishoreganj and Netrokona districts outside the core *haor* area. It is a mosaic of wetland habitats, including rivers, streams and irrigation canals, large areas of seasonally flooded cultivated plains, and hundreds of *haors* and *beels*. This zone contains

about 400 *haors* and *beels*, varying in size from a few hectares to several thousand hectares. The *haors* are enriched with various aquatic biodiversity's along with 140 species of fish.

The rivers and several *haors* in greater Sylhet are famous for producing huge amount of fish during late monsoon. During this time rivers, *beels* and *haors* remain calm and quiet and also the fishes becomes marketable size grazing in this rich waterbodies as a result fishing activities are strengthened and huge fishes are harvested during this period than the other seasons. Therefore, a glut is obtained from the *haor* area during winter season. As huge quantity of fresh fish caught every day, remains unsold because of shortage of customers. As a result a huge amount of post-harvest loss occurs and bulk catch destroyed due to unavailability of processing and preservation facilities. Therefore, the local people and also some entrepreneurs come forward and they do drying fish, a traditional process of fish processing in Bangladesh from the ancient time. Conservation of fish by drying is common practice in Bangladesh.

In Sylhet region, a huge amount of fishes are caught every year. After mitigating local demand of fresh fish, a large amount of fish remain unsold. It is well known that, fish is an extremely perishable food commodity and there is no other kind of food observed which have so serious loss at every stage from harvest to consumption. To improve the existing condition it is necessary to understand the present status of drying activities. Although, several research works on fresh fish marketing and few efforts on fish drying have been conducted in Bangladesh but no such work has been done on traditional sun drying activities of north-east part of Bangladesh especially in Sylhet district.

Besides, dried fish processors of Bangladesh are socially disadvantaged and lacking their basic needs. Dried fish processors are living below the poverty line and struggling with poor health condition, nutrition, sanitation, education, housing etc. Although, few scientific articles on household socio-economics, resource use of dried fish processors have been conducted in Bangladesh but no such research work was found especially on socio-economic condition of dried fish processors in Sylhet district of the country. Thus the present study was conducted to evaluate the status of fish drying activities and socio-economic condition of dried fish processors in two upazilas of Sylhet district.

Although fish drying is a traditional process but dried fish (*shutki* in Bengali), is a popular food item in Bangladesh especially, in the northern and coastal districts. It is the main protein source in many areas of this country. Moreover, there is a great scope of exporting

dried fish to abroad because there are many Bangladeshi immigrants and workers in other countries. Also it has a high demand in the South and South-east Asian countries.

Edible fishes preserved through removal of moisture. Fish drying as a means of preservation has been practiced since time immemorial in this region, and dry fish is considered as a delicacy in the menu of many people of Bangladesh. The basic principle of fish drying is that the activity of the muscle enzyme and microorganism is reduced to a minimum through drawing out the water content of the fish by sun drying in a traditional way. Fish drying is carried out in some selected coastal areas and inland depressions of Bangladesh where modern preservation facilities and good infrastructure for transportation are absent. We should first investigate the status of fish drying and what is their future plan for development for a comprehensive development of fish preservation facilities of over harvested fishes during monsoon for fulfilling the nutritional requirement during lean period without damaging a bulk catch in the peak season.

In the above context, the present study has been undertaken to achieve the following objectives:

1. To investigate the present status of fish drying in two upazilas of Sylhet district;
2. To know the socio-economic condition of the people involved in fish drying activities;
3. To recommend the improved fish drying strategies.

CHAPTER TWO

REVIEW OF LITERATURE

The purpose of this chapter is to review the previous research works which are related to the present study. The literature on status of fish drying condition in two upazilas of Sylhet district is rare. However, some work or study about fish drying is carried out by some researchers in Bangladesh and abroad. The most relevant studies which have been conducted in the recent past years and related to this research are reviewed below:

2.1 Dry Fish and Fish Dryer

Clucas (1982) stated that fish drying is an age long practice across the world. It is one of the methods of processing fish. Drying is the removal of water from fish. Normally the term 'drying' implies the removal of water by evaporation but water can be removed by other methods: for example, the action of salt and the application of pressure will remove water from fish. Since water is essential for the activity of all living organisms and its removal will slow down, or stop, microbiological or autolytic activity and can thus be used as a method of preservation.

Flowra and Tumpa (2012) conducted an experiment on five selected traditionally dried fish species *Puntius ticto, Labeo bata, Wallago attu, Channa striatus* and *Palaemon* sp. from the Chalan beel area of Bangladesh. The analytical data on chemical composition showed that the moisture content varies from 12.13% (*Puntius ticto*) to 18.18% (*Palaemon* sp.). Ash content ranged from 10.78% (*Labeo bata*) to 15.67% (*Palaemon* sp.). Protein content of selected dried fishes varied from 28.20% (*Wallago attu*) to 51.19 % (*Palaemon* sp.). Fat content of the dried fishes varied from 5.38% (*Labeo bata*) to 15.86 % (*Wallago attu*).

Jamila and Ranjitha (2009) conducted an experiment to assess the nutritive values and microbial qualities of commercially and experimentally sun dried fin fish, *Scomberoides tol*. The present study reveals that the fish was dried experimentally on fish drying rack that had good nutritional qualities and hygienic compared to the commercially sun dried fish from the same species.

Siddique and Aktar (2011) studied on changes of nutritional value of three marine dry fishes (*Johnius dussumieri, Harpodon nehereus* and *Lepturacanthus savala*) during 2 years storage period. The result of this study shows that the mean percentage of moisture

content increased at a significant level with the increasing of storage period. The moisture content percentage is increased by 12.77 11.89 and 6.69; and the mean percentage of protein (6.35, 7.93 and 4.68), lipid (1.92, 0.67 and 1.13), where carbohydrate percentage varied (1.70, 1.81 and 0.66) of three dry fishes (*Harpodon nehereus, Johnius dussumieri* and *Lepturacanthus savala*, respectively) decreased greatly for 2 years storing period. The findings of this study showed that nutritional value of dry fishes deteriorate with the increasing of storage period.

Flowra *et al.* (2012) conducted a study on traditional fish drying activities at different fish drying points of the Chalan beel area at Tarash Upazila under Sirajganj district. There were nine fish drying points in the study area. Twenty one fish species were identified for drying in the study area. Most of the fish drying points were operated seasonally (from July to March). Raw fishes were collected from local fish markets or landing centers. Transportation of raw fish was done by non-mechanized van, rickshaw or by head load. The peak period for drying was September-October. The rate of mixing salt in the study area was found as 1kg salt for 13 kg of raw fish. At normal weather, the drying duration was recorded as 2-6 days depending on the size of the raw fishes. Average monthly income of dry fish processor was found to vary from Tk. 2,000 to Tk. 15,000.

Reza *et al.* (2005) conducted a study to evaluate the present status of traditional drying activities of commercially important marine fishes in the coastal region of Bangladesh. After harvesting, the small scale fisherman carry their catch to the landing center in traditional bamboo baskets without using adequate ice and poor quality fishes are used as raw materials for dried fish processing. There is also widespread use of insecticides before and after drying to avoid insect infestation. The dried products contaminated with molds and fungus is common in the retail and wholesale markets in Chittagong and Cox's Bazar dried fish markets. Due to the involvement of various middlemen in the marketing chain of fresh and dried fish causes to buy the products with a higher price.

Bhat *et al.* (2013) conducted a study in district Bandipora that is one of the major fish producing districts of Kashmir valley. Sun drying of fish adopted by all the fishers of this district and contributes significantly to their income. The conventional method employed in drying of fishes is unscientific and can cause serious health hazards. Quality assurance of processed fish is of utmost concern that has greater implications from health point of view. In this backdrop, the present study conducted to investigate the traditional method of fish drying.

Samad *et al.* (2009) conducted a study on fish drying in Chalan *beel* areas. Twenty six fish were used for drying including five major fish species for large scale drying and remaining species were mixed with major species, mostly of damaged physically. Majority (89.30%) dry fish farmers brought raw fishes from local fish markets or landing centers. Washing of raw fish was done by *beel* water and poor quality salts were used for salting (rate: 50-250 g/kg fish) in most cases. Majority drying were done by spreading raw fishes on bamboo rack without any protection measure from insects or dust. At normal weather condition drying duration recorded to be varied from 2-6 days depending on the size of the raw fishes. Finally, maximum dried products were carried to Sayadpur of Nilphamary district, a dry fish wholesale market by the dry fish farmers or other middlemen.

Latif *et al.* (1983) conducted a study on the status of the dried fish processing industry in the East Coast states of Kelantan and Terengganu. Ten districts were visited. Overall, most fish were processed in the months of August, September and October for processors in Terengganu, and in the months of March to October in Kelantan. The quantity processed per batch is different. This paper also noted the quality and characteristics of dried fish were identified by the processors. Important characteristics in determining the quality of dried fish include saltiness, appearance, color, dryness and aroma. Most processors agreed that freshness of fish before processing is a very important factor in producing good quality dried fish. Problems faced by processors in processing, storing and distributing the products were also looked into. Identification of these problems decides whether any improvement in processing and drying technology can be achieved.

Davies and Davies (2009) reported that six different types of traditional fish processing techniques were in use in the Niger-delta part of Nigeria. These techniques were characterized with inefficient utilization of fuel wood, poor quality of fish due to lack of control over the temperature of the fire and smoke density, labor intensive and low capacity. Three improved technologies were equally observed in Bayelsa. They are; drum oven, mud oven, and chorkor kiln. The chorkor kiln proved to be a successful technology with high efficiency in fuel uses, easy to operate and maintained, high batch capacity and produces evenly smoked fish which fetches high market value.

Rabbanee *et al.* (2012) studied about women involvement in dry fish value chain approaches which covers seven different villages of Cox's Bazar districts. A total of 280 women workers having 140 fisherwomen and 140 women workers, were selected for the study. It points out that the women are involved in different income generating activities

like drying, sorting and grading, cleaning and salting. Finally, it suggests some innovative marketing strategies to overcome the vulnerable situation faced by the fisherwomen and adopt better livelihood strategies and thus attain sustainable livelihood through better livelihood outcome.

Ichsani and Dyah (2002) developed a Solar Dryer in Indonesia which combined with kerosene stoves to dry Fish. The solar dryer hybrid system can be used in all seasons and gives alternative for selecting the source energy. This dryer system provides better product quality than the open sun drying.

Bellagha *et al.* (2002) in their experiment to determine the drying kinetics and characteristic drying curve of lightly salted sardines (*sadinella aurita*) reported that higher air temperature produced a higher drying rate and reduced drying period. This was due to the increase of the air heat rate to the product and to the acceleration of water migration inside the fish. Similarly, drying rate increased with increase air velocity but lessened at higher air flow velocities, due to hardening of fish surface caused by protein modification as a result of the combined effect of heat and salt.

According to the report of a study conducted by Olokor *et al.* (2009) fish weight loss in solar dryers differs in the ecological zones of Nigeria with the North-East recording highest value while the value of weight loss was least in South Nigeria; this was attributed to the influence of relative humidity on drying. Drying method is however dependent on the nature of fish to be dried, size, quantity and consumer requirement in taste, quality and economic considerations.

Bhuiyan *et al.* (2008) conducted a study on the concentrations of organ chlorine insecticides DDT and heptachlor used in dry fish and these dry fishes were collected from different markets of Dhaka and Chittagong. The most popular dry fish– ribbon fish (chhuri), shrimp (chingri) and bombay duck (loittya) were selected for this study. The range of DDT used in all the samples was 3.038 ppb (parts per billion) to 874.966 ppb. The range of heptachlor used in all the samples was 0.682 ppb to 5.464 ppb. The concentration of heptachlor in dry fish compare to DDT was found too much less.

Rahman *et al.* (2012) developed low-cost emergency fish dryer in the Marine Fisheries & Technology Station, Cox's Bazar, Bangladesh to use in absence of sunlight and during the bad weather. Three models of low-cost fish dryers were designed and developed using locally available materials in Bangladesh. The first model was developed to use in an emergency situation, i.e. to meet the emergency need in the absence of the sunlight. The

second model was developed using transparent plastic wavy sheet (plastic tin) to utilize the solar energy during the sunny day and hence to make it useful for 24 hours a day. The third and final version of the transparent model was named as the BFRI Fish Dryer that was constructed using two layers of thin (0.20 mm) celluloid for better insulation and efficient utilization of heat energy. The organoleptic (sensory) characteristics, water reconstitution properties and nutritional properties on the basis of proximate compositions of the dried fish products produced in the BFRI Fish Dryer were found very attractive compared to the traditional products. Thus, this technology can ensure food safety through producing hygienic dry fish.

2.2 Dry fish Market and Marketing Channel

Faruque *et al.* (2012) investigated a dry fish market at Asadganj in Chittagong district of Bangladesh. They observed that several species of coastal and marine dried fish were commonly available in the market. The price of dried marine fish depended on the size, availability, quality of the species, transport, labor and season. The major cause of price exploitation to the producers was dadan (non-institutional money lending) that compelled the producers to go for 'conditional engagement' in the fish drying business. Bombay duck, having 24.88% was the highest quantity found in this market. Stakeholders of the market faced various problems like inadequate capital, natural calamities, lack of scientific knowledge and technology, price instability, lack of transport facilities, lack of inadequate storage facilities, lack of physical marketing facilities, lack of marketing information, etc.

Sugathapala *et al.* (2012) conducted a study on salt based dry fish processing and marketing by fishers of Minneriya reservoir in Sri Lanka. For processing, small (6.875-8.750 cm) and damaged fish are collected, split ventrally, and the gut and skin are removed completely. Fish are then washed thoroughly and salted at a ratio of 1:3 (salt: fish), mixed well and packed into plastic buckets (20L) and kept for 2-3 day. The salted fish are then spread on large stones and sun dried. Carcass recovery of fish was 33.3%. Dry fish was sold to grocery stores at Minneriya and to the Dambulla market, with a profit of Rs. 255/- per kg and a market margin of 72.9%. The findings indicate that dry fish marketing is a profitable, low cost option for small-scale producers in Minneriya.

Amin *et al.* (2012) studied about the marketing channel of dried marine fish from Kutubdia Island to Chittagong city. The marketing chains from producers to consumers passed through a number of intermediaries: beparies, aratdars, wholesaler and retailer. They enlisted the price of some dry fishes that are available in the study area. The price

was increased nearly double from producer to consumer. During peak season price was lower than that of lean season. Processors and intermediaries faced various problems like inadequate capital, natural calamities, lack of scientific knowledge and technology, price instability, lack of transport facilities, lack of inadequate storage facilities, lack of physical marketing facilities and lack of marketing information.

Nayeem *et al.* (2010) conducted a survey on the marketing system of traditional dried and semi-fermented fish product locally called "*Chepa shutki"* of local markets of Mymensingh region, Bangladesh. It showed that there was no fixed marketing channel for those products and the length of marketing chain varied depending on location and season. The study showed that 63% of the retailers were satisfied with their existing socio-economic condition and they ranked themselves in the society as businessmen.

2.3 Biodiversity

Simply biodiversity can be defined as the variety of all life forms: the different plants, animals and microorganisms, their genes and the ecosystems of which they are a part. Biological diversity is defined as the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are apart: this includes diversity within species, between species and of ecosystems (CBD, 1994).

Biodiversity is the variety of life and its processes. It encompasses genetic species assemblage, ecosystem and landscape levels of biological organization with structural, compositional and functional components (Noss, 1990; Cairns and Lackey, 1992). Biodiversity is generally recognized at four levels in a biological hierarchy (Noss, 1983; Norse, 1986; OTA, 1987): i) Genetic diversity, the sum total of information in the genes of individual organisms or in a species; ii) species diversity, the number and frequency of organisms in a given area; iii) ecosystem diversity, the variety of ecological processes, communities, and habitats within a region; and iv) landscape diversity, the spatial heterogeneity of the various land uses and ecosystems within a large region.

IUCN (2000) of Bangladesh enlisted a total of 266 inland and 442 marine fishes. The review mentioned there was no stock-taking and monitoring of this wealth.

Rahman (2005) reviewed that floodplains of Bangladesh are very rich in floral and faunal biodiversity. He also reported that outstanding among the riverine fishes are the carps and

minnows of the family Cyprinids and a large variety of catfishes belonging to 11 families and 33 genera are endemic to Bangladesh.

Sarkar *et al*. (2008) studied about the biodiversity status of freshwater catfish in some selected waterbodies of Bangladesh. The fish samples were collected from Sylhet, Sunamgonj, Mymensingh, Netrokona, Kishoregonj, Comilla, Chandpur, Dinajpur, Chapai Nawabganj and Satkhira districts of Bangladesh. A total of thirty eight species of catfishes belonging to 11 families were recorded.

Mazid (2002) recorded a total of 92 species of fish and prawn from the Sylhet-Mymensingh basin. In the Sylhet sub basin barbs (*Puntiu*s spp.) were the most dominant group comprising 19% of the total catch and the catfishes (*Wallago, Aorichthys, Mystus, Clupisoma, Clarias, Heteropneustes* etc.) contributed to about 18% of the total catch. In the Mymensingh sub-basin, unlike the Sylhet sub-basin, barbs and minnows, the Gangetic major carps and various kinds of prawn were the dominant species in the catch. The report highlighted a total of 13 barbs and minnows like *Puntius sophore, Puntius sarana, Puntius ticto, Puntius conchonius, Puntius gelius, Puntius chola, Osteobrama cotio, Amblypharyngodon mola, Esomus danricus* etc.

Nuruzzaman (1997) conducted a study on fish biodiversity of Tanguar *haor* in Sunamganj district and recorded a total of 104 species of fish from the *haor*.

FAP-17 (1995) highlighted the present status of fish fauna including non-stocked indigenous fish species with regard to their diversity, yield, distribution, abundance and movement inside and outside the Flood Control Drainage and Irrigation (FCDI) projects in different parts of Bangladesh. The study reported a total of 120 fish species between August 1992 and February 1994.

According to the FAP-17 (1994) there is a lot of seasonal and regional variation in the quantity and type of fishes available in local markets. Small fish such as punti, royna and koi dominate the rural markets. The *beel* harvest peaks between January and April, whilst the river harvest peaks during November and December. Floodplain species arrive in the markets between May and December, with a peak between October and December.

CHAPTER THREE

MATERIALS AND METHODS

To fulfill the objectives the present study was conducted. The materials and methods of the study are as follows:

3.1 Description of the Study Area

The Sylhet district is situated in 24.70^0 north latitude and 91.67^0 east longitudes. The present study was carried out at Tuker bazar, Mahatabpur and Amtoli. Tuker bazar is situated in Sylhet sadar upazila (Fig. 3.1); Mahtabpur and Amtoli are situated in Bishwanath upazila (Fig. 3.2) in Sylhet district. The study was conducted for a period of five months from October 2012 to March 2013.

3.2 Study sites

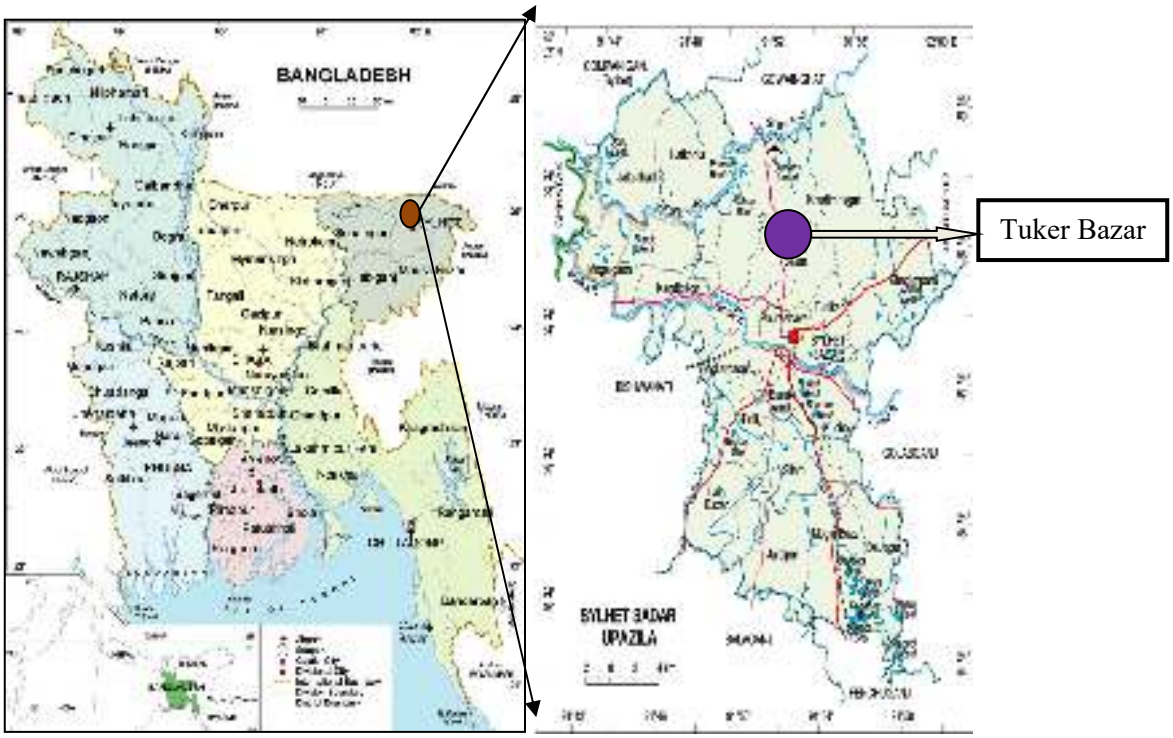

Fig 3.1: Map of Bangladesh and Sylhet district showing the Tuker Bazar fish drying area

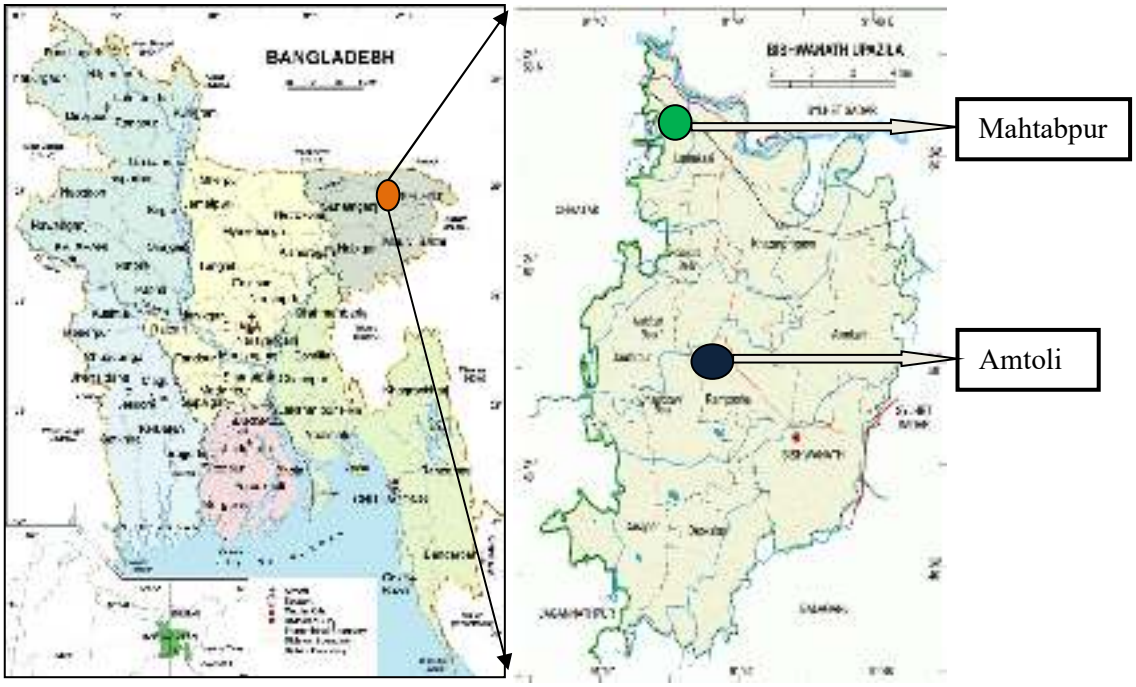

Fig. 3.2: Map of Bangladesh and Bishwanath upazila showing Mahtabpur and Amtoli fish drying areas

3.3 Target groups

The people those are involved in drying fish termed as dried fish processor. Target group for the study was the dried fish processor to have a clear picture of the fish drying in Sylhet districts as well as Sylhet region. Two categories of workers are involved in this processing industry situated in this area i.e. the owners of drying enterprises, and the processors or laborers. The later also include female workers and children's. Generally they are involved in sorting and preparation of the raw materials for dried fish.

3.4 Sample size

A total of 20 dried fish processors were interviewed from the study areas that were selected randomly (6 from Tuker Bazar, 8 from Mahtabpur and 6 from Amtoli).

3.5 Preparation of questionnaire

A semi-structured questionnaire was prepared and then modified with necessary corrections for field data collection.

3.6 Data collection

Questionnaire based interview was taken in collecting data for the present study. The respondents were interviewed in their convenient time. The questionnaire was in English but they were asked in Bengali and in their local language as much as possible. Data were

collected by weekly from the respondents on a regular basis. The flow diagram of survey work is presented in Fig. 3.3.

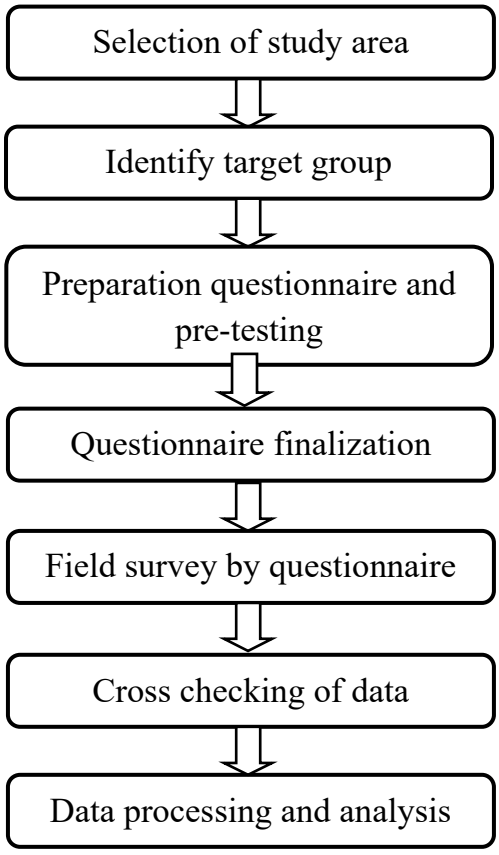

Fig. 3.3 Flow diagram of survey work

3.7 Cross-checking of Data

The data were cross-checked with direct interview with the respective Upazila Fisheries Officers and other stakeholders including fishers as a cross-checking method. The collected data were also reviewed with the secondary data sources mainly reports of the Department of Fisheries (DoF), research reports, case studies, NGO reports, scientific journal articles and other published materials including internet resources.

3.8 Data analysis

Then collected data were summarized and tabulated. Finally tabulated data were analyzed by using computer software Microsoft Excel and for statistical analysis of raw materials, final production and production cost and wages data, one way analysis of variance (ANOVA) was performed and also were compared in a repeated measure ANOVA. If the main effect was found significant, the ANOVA was followed by Duncan's Multiple

Range Test (DMRT) to compare the variations among the treatments means. All statistical tests were carried out at a 5% significance level using SPSS (Statistical Package for Social Science) (Version 11.5, SPSS Inc, and United States of America).

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Fish drying activities

4.1.1 Fish drying yard

Traditionally sun-drying is carried out in the open air, using the energy of the sun to evaporate the water and air current to carry away the vapor. For this reason fishes were mainly dried in the open place. Sufficient sunlight and wind were available in this open place and suitable for drying activities. Drying yards are situated near the fish market or highway for easy communication. Some drying yards are also situated near the bank of river as river water is used for washing activities. Fresh fish are collected from nearby fish markets or from adjacent *haors* and *beels*. There were twelve, twenty and six fish drying points observed in the Tuker Bazar, Mahtabpur and Amtoli village area in Sylhet district. Among them Mahtabpur is the largest fish drying area. Most of the fish drying points have a well-marked territory. Bamboo marked territory is called *'Dangari'*. For drying purpose they used both bamboo made mat and rack. In Tuker Bazar and Amtoli areas, maximum drying activities are carried out in bamboo mat but in Mahtabpur areas, maximum drying activities are carried out in bamboo made rack. Under the bamboo rack, dressing of larger fresh fish and sorting of dried fish are carried out by women labors.

Plate 4.1 Fish drying at Tuker Bazar, Mahtabpur and Amtoli points in Sylhet

The fish drying activities at three studied area are presented in Plate 4.1. Drying activities in large scale have been found in these areas i.e. they perform these activities for commercial purpose. Some households are also used to dry fishes only for household

consumption but not for sale. The hygienic conditions of those areas are not satisfactory. Although the fish drying points are separated from the locality, the smells of the dried fish are traditional and unscientific which can cause serious health hazard, also pollute the environment. Bhat *et al.* (2013) conducted a study in district Bandipora that is one of the major fish producing districts of Kashmir valley. The conventional method employed in drying of fishes is unscientific and can cause serious health hazards which agree the findings of the present study.

4.1.2 Species used in sun drying

Various types and sizes of fish are used in drying purpose. Generally, small fishes are selected for drying than larger ones. A list of different fish species used for traditional sun drying in different fish drying areas with their drying duration are shown in Table 4.1. A total of 23 fish species were observed to be used for sun drying in the study area during the study period. For commercial sun drying, fish species were selected depending on both availability and market demand. Fish species used in sun drying were divided into two main categories (i) high priority fish species (97% of total dried fish) and (ii) less priority fish species (3% of total dried fish). High priority fish are selected on the basis of fish availability, price of the fish, ease of drying and consumer demand etc. Drying duration extremely varied with weather conditions like available sunlight, temperature, relative humidity, wind flow, raining status etc. Drying duration varied from 2 to 6 days depending on the size of the raw fishes at normal weather condition. But in cloudy weather it takes 2 to 4 days or more. This finding is more or less similar to the result of Flowra and Tumpa (2012), Samad *et al.* (2009).

Table 4.1 Available fish **s**pecies that are used for sun drying in the study area

Category	Fish Name	Scientific Name	Drying duration (day)
High priority fish	Punti	*Puntius* sp.	3-5
	Chanda	*Chanda* sp.	3-4
	Kakila	*Xenentodon cancila*	3-4
	Tengra	*Mystus vittatus*	3-4
	Kholisha	*Colisa* sp.	2-3
	Baim	*Mastacembelus* sp.	5-6
	Chingri	*Macrobrachium* sp.	2
	Chapila	*Gudusia chapra*	3-4
	Mola	*Amblypharyngodon mola*	2-3
	Dhela	*Rohtee cotio*	2-3
	Meni	*Nandus nandus*	3-5
	Batasi	*Pseudeutropius antherinoides*	3-4
	Bacha	*Eutropiichthys vacha*	2-3
	Darkina	*Esomus danricus*	2-3
	Rani	*Botia dario*	2-3
	Gutum	*Lepidocephalus guntia*	2-3
	Buzuri	*Mystus tengara*	3-4
	Bele	*Glossogobius giuris*	3-4
Less priority fish	Potka	*Tetraodon* sp.	4-5
	Shol	*Channa striatus*	5-6
	Boal	*Wallago attu*	5-6
	Taki	*Channa punctatus*	2-3
	Gojar	*Channa marulius*	5-6

4.1.3 Season and seasonal income of fish drying activities

In the study area, fish drying generally starts in mid-October and ends in mid-March. During this period sufficient sunlight was available throughout the day and wind moisture content is less. Not only that fish drying activities are depended on the raw materials availability, weather condition and market demand. Dried fish processors engaged in this business for only five months, rest of the time they involved themselves in other types of income generating activities such as rickshaw pulling, grocery shop, fresh fish and dried fish selling or other types of businesses. Flowra and Tumpa (2012) also conducted a study in Chalan *beel* area and found most of the fish drying points were operated seasonally (from July to March) where the peak period of drying was September- October which coincides the findings of the present study.

The seasonal income of drying enterprise varies from area to area. This variation is due to the raw material availability, processing cost and demand of the consumers. In Tuker Bazar and Mahtabpur areas, many people are engaged in drying. The average seasonal income of fish drier enterprise in three study areas is given below in Fig. 4.1.

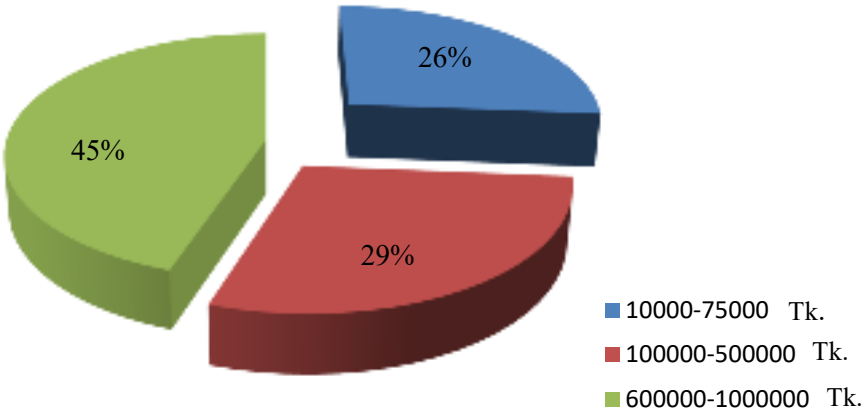

Fig. 4.1 Percentage of seasonal fish drier enterprise in different income groups

From the diagram it is clear that 26.31%, 28.94% and 44.73% fish drier enterprises were found in the income range of Tk. 10000-75000, Tk. 100000-500000 and Tk. 600000-1000000. The data revealed that only nearly half of the fish drier entrepreneurs have the handsome earnings from the business. Flowra and Tumpa (2012) studied about the mean monthly income of dried fish processors in Chalan beel area and found 30.71%, 50.00% and 14.28% seasonal dried fish processors are grouped into the TK. 2000- 5999, Tk. 6000-10999 and Tk. 11000 -15000 income range. The earnings of the processors in the

present study are higher than Flowra and Tumpa (2012). The difference in income range may be due to the scale of drying activities, raw materials availability and the consumer preference about dried fish in certain area. Therefore, it is very much profitable and suitable businesses in this area as the seasonal fishes are available during glut catch.

4.2 Method of Traditional Sun Drying of Fish

4.2.1 Raw material collection system

Raw fishes are harvested by fishermen from rivers, *haors, beels* and cultured ponds. Then the fishes are brought to the nearest markets by rickshaw, van, pickup van, truck etc. As soon as the fish reach the market, the local fish traders and agents take care of landing, handling, sorting and auctioning by species and size-groups. Auctioning is a common system for price-fixation of fish in the fish markets. It was observed that during the peak season, when large volumes of fishes are harvested, the processors collect the raw material at cheaper price for production of dried fish products. The study reveals that the processors use poor quality raw materials for production of dried fish products. This is due to the use of inadequate ice, rough handling, lack of cool chain management system and longer exposure of the raw materials at higher temperature at different stages of handling and transportation, contamination and lack of knowledge of the processors about the quality aspects. The finding of the present study agrees with the findings of Reza *et al.* (2005).

Latif *et al.* (1983) studied on the status of the dried fish processing industry in the East Coast states of Kelantan and Terengganu where most processors agreed that freshness of fish before processing is a very important factor in producing good quality dried fish which coincides with the present finding. Most of the dry fish farmers collected raw fishes from local fish markets or directly from adjacent *haors* and *beels*. Some fishermen directly brought their harvested fish in the drying areas. In the Tuker Bazar fish drying area, they collect fish from Kazir Bazar fish market, in Mahtabpur fish drying area, they collect fish from Mahtabpur Bazar fish market, but in Amtoli fish drying area, they collect fish from adjacent *haor* named '*Boro haor'* and small scale drying activities were practiced there. Handling practices of raw materials in the studied areas are shown in Plate 4.2.

Plate 4.2 Collection of raw materials for drying in the study area

Directly fishermen also sell their catches into the drying yards. The collection quantity of raw fish was depended on price and availability of raw fish. Dry fish farmers use either large or small fish for drying or both, depending upon their choice. Generally, semi-spoiled fishes are used as raw materials for drying. This finding is more or less similar to Reza *et al.* (2005). Raw fish was transported from fish markets to fish drying point mainly by non-mechanized van, rickshaw, boat and bicycle or by head load or shoulder load.

4.2.2 Processing of fish

After collection of fish, they used it for processing. Sorting of fish is not common before drying in the study area. It is practiced to separate the fish according to the species, quality and size of the fish after completion of drying. Mainly female workers are engaged in sorting of fish. By sorting, small and large fish and fresh and rotten fish are separated and other particles are sorted out. Primary washing is not common after collection of fresh fish for drying. Scaling and gutting are not common in those areas. Dressing is observed there for larger fishes like large *Puntius* sp.*, Wallago attu, Channa striatus* and *C. marulius* and splitting is also observed for *W. attu, C. striatus* and *C. marulius* which is done for uniform drying of all parts of muscle. It is observed that the entire Small indigenous species (SIS) of fish are directly dried under the sun without any dressing. The findings agree with the findings with Samad *et al.* (2009).

Plate 4.3 Salting of fish before spreading in the study area

Salting protect the dry fish from spoilage and ensure long time preservation. Addition of salt is also practiced in these areas. The production of salted or unsalted dried fish depends on the choice of processor, consumer demand and market price of the product. But they only use salt in fish in the cloudy weather. The salting procedure of fishes is shown in Plate 4.3. The rate of salt mixing is observed as 1 Kg salt per 8-10 Kg of fishes. All the dry fish farmers used non-brand commercial salt for this purpose. The salt quality is not so good. Mixing of salt can be done by a wooden pole. Then it is used to keep covered by bamboo mat for 5-7 hours.

Plate 4.4 Washing of salted fish in water containing plastic drum

After salting, fishes are used to wash in water for the removal of salt. Dry fish farmers washed their fish with nearby river water or pond water as there were no good water supply sources in drying areas and in Amtoli village dry fish farmers used *haor* water for this purpose. In most cases, fishes are used to wash in water containing plastic drums. The

water of the drums is not changed frequently after washing a batch. The waste water is also dumped in the nearby areas. The remaining salts in the waste water are strained and sun dried which are used in salting for second time use in fresh fish. The present finding is agreed partially with Flowra *et al.* (2012). Sugathapala *et al.* (2012) also studied about salt based dry fish processing and marketing by fishers of Minneriya reservoir in Sri Lanka. For processing, small and damaged fish are collected, split ventrally, and the gut and skin are removed completely. Fish are then washed thoroughly and salted at a ratio of 1:3 (salt: fish), mixed well and packed into plastic buckets (20L) and kept for 2-3 day. The salted fish are then spread on large stones and sun dried. But in Sylhet district, Salting of fish can be done for 5-7 hours and 1 Kg salt is used for 8-10 kg fish. Gutting is only applied for larger fishes but skinning of fish is not practiced here. It is used less amount in fish than Sugathapala *et al.* (2012) this may be the climatic condition of Bangladesh. In Bangladesh, during the drying season moisture content of air is comparatively less. This may be the reason for using less amount of salt.

4.2.3 Chemicals used in fish drying

In Mahtabpur and Amtoli areas, they didn't use any type of chemicals or preservatives to store the dry fishes for long time both during processing and storage because their products are sold within a very short period of time. But in Tuker bazar areas, few processors use agricultural pesticides for long time storage and prevention of blowflies' infestation in dried fish. Most citable of them are DDT and Nogos. Both are banned for any use in Bangladesh. There is no control over the dosage used. Both Nuvacron and Basudin are permitted to control pests in crops and vegetables, but not allowed for direct application to foods. The processors or laborers have no knowledge about pesticide action, dose limit and residual effects. They used 5-6 drops of pesticides in 80 liter of water during washing of fresh fish. The extent of pesticide use is sharply reduced in sunny days. If the storage time prolongs, processors check the condition of the stored products at certain intervals. If any further infestation is found, the product is treated with the pesticides again after a day of drying. Reza *et al.* (2005) studied about the present status of traditional drying activities of commercially important marine fishes in the coastal region of Bangladesh and observed that the processors soak the raw fishes in various kinds of insecticides including DDT, Nogos (Dichloroves) prior to drying. They used concentration ranging from 20-80 ppm (parts per million). Bhuiyan *et al.* (2008) studied about the concentration of DDT and heptachlor used in dry fish and found the range of DDT used in all the samples was 3.038 ppb (parts per billion) to 874.966 ppb. The range of heptachlor

used in all the samples was 0.682 ppb to 5.464 ppb. The concentration of heptachlor in dry fish compare to DDT was found too much less. Red pepper and turmeric powders have pesticidal effects. These spice powders, at a rate of 1-2%, either mixed or separate, can be added inside the abdominal and gill cavities and on the body surface. However in the study areas, they were not interested about it because spices change the original fishy color of dried fish and consumers are also not interested about it.

4.2.4 Drying under the sun

The process of drying varies according to the fish size and also some extent, choice of the consumers. For comparatively large scale (business purpose) fish drying, bamboo made rack of 1.5-3 feet high from earth was used in most cases. A bamboo splits made mat was used on the rack over which raw fishes were spread for drying. In some places, fishes were spread on mat directly on earth without using any bamboo rack. The finding agrees with the findings of Samad *et al.* (2009).

Plate 4.5 Spreading of fish in bamboo mat for sun drying

Sometimes large fishes like *W. attu, C. striatus* and *C. marulius* were hanged from a rope tied horizontally to the two poles placed vertically for drying instead of using any rack. But at the present time, drying of larger fishes is not common due to the scarcity of raw materials. Drying rate depends on some factors such as relative humidity of air, air velocity, air temperature and surface area of fish. Generally 2-6 days are required for drying in each batch of fish. The spreading of fish on bamboo mat in the studied areas is shown in Plate 4.5.

4.2.5 Sorting of fish

Except larger fishes, other fishes remained mixed condition and were sorted out after drying. Generally women workers sorted out the mixed dried fishes and separated the fish

according to the species, size and quality of the dried fish. The sorting activities for drying fish in the study areas are shown in Plate 4.6.

Plate 4.6 Dried fish sorting by women workers

4.2.6 Packaging and storage

After drying, packaging of the dried fishes can be done by plastic and jute made bags for easy handling. Sometimes bamboo baskets (which are called *'tukri'* locally) were also used for this purpose. The size varied with the quantity of the product to be stored. Storage of dried fish was found to be performed in the *'Dangari'* generally made of thin tin, wood and bamboo splits.

Plate 4.7 Bamboo basket is used for storage of dried fish

This *'Dangari'* was usually made in the place of fish drying yard by bamboo or plastic materials. Almost similar assumption was made by Rubbi *et al.* (1982). Bagged dried fishes were kept into these *'Dangari'* for temporary storage until marketing or selling to

the local vendors in the study areas (Plate 4.7). If any infestation was found during storage of the stored product, sun drying was performed again for 1-2 days and restored.

4.2.7 Transportation and marketing

Dried fishes were transported from drying point to wholesale market by non-mechanized van, rickshaw, bus, boat etc. Pickup van and track is also used to transport dry fishes into distant areas. In Tuker Bazar areas, some dried fishes were transported via boats.

Plate 4.8 Transportation of dried fish

In Mahtabpur and Tuker Bazar areas, they sell their products to the Aratdars of Shorarpar, Mahajanpur and Masimpur Bazar dry fish market. In case of Amtoli areas, they sell their product in Rampasha Bazar or adjacent areas. The transportation system of dried packaged fishes is shown in Plate 4.8.

Marketing channel of dried fish in the study areas consisted of dry fish farmers, several intermediaries (local vendor, Aratdar, wholesaler and retailer), and consumer. A common dried fish marketing channel was observed during the investigation period.

In Bangladesh, there is a lack of marketing infrastructure for both wholesale and retail markets. Transportation and storage facilities are poor in most part of the country. The involvement of large number of middlemen and commission agents reduce benefit to the fish producers. Amin *et al.* (2012) studied about the marketing channel of dried marine fish from Kutubdia Island to Chittagong city.

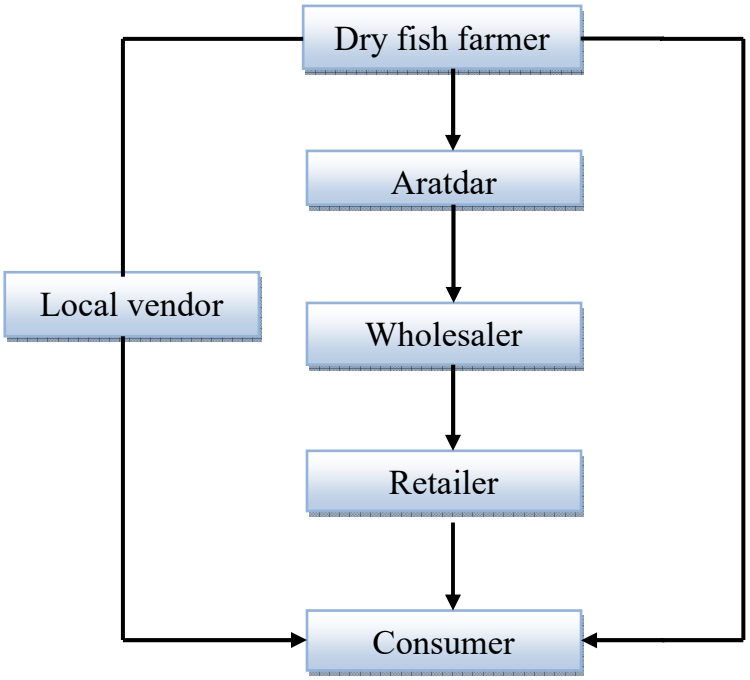

Fig.4.2 Marketing channel of dried fish in Sylhet

The marketing chains from producers to consumers passed through a number of intermediaries: beparies, aratdars, wholesaler and retailer which agrees with the findings of the present study.

4.3 Drying activities in study areas

Flowchart of overall fish drying activities in the study areas is given below:

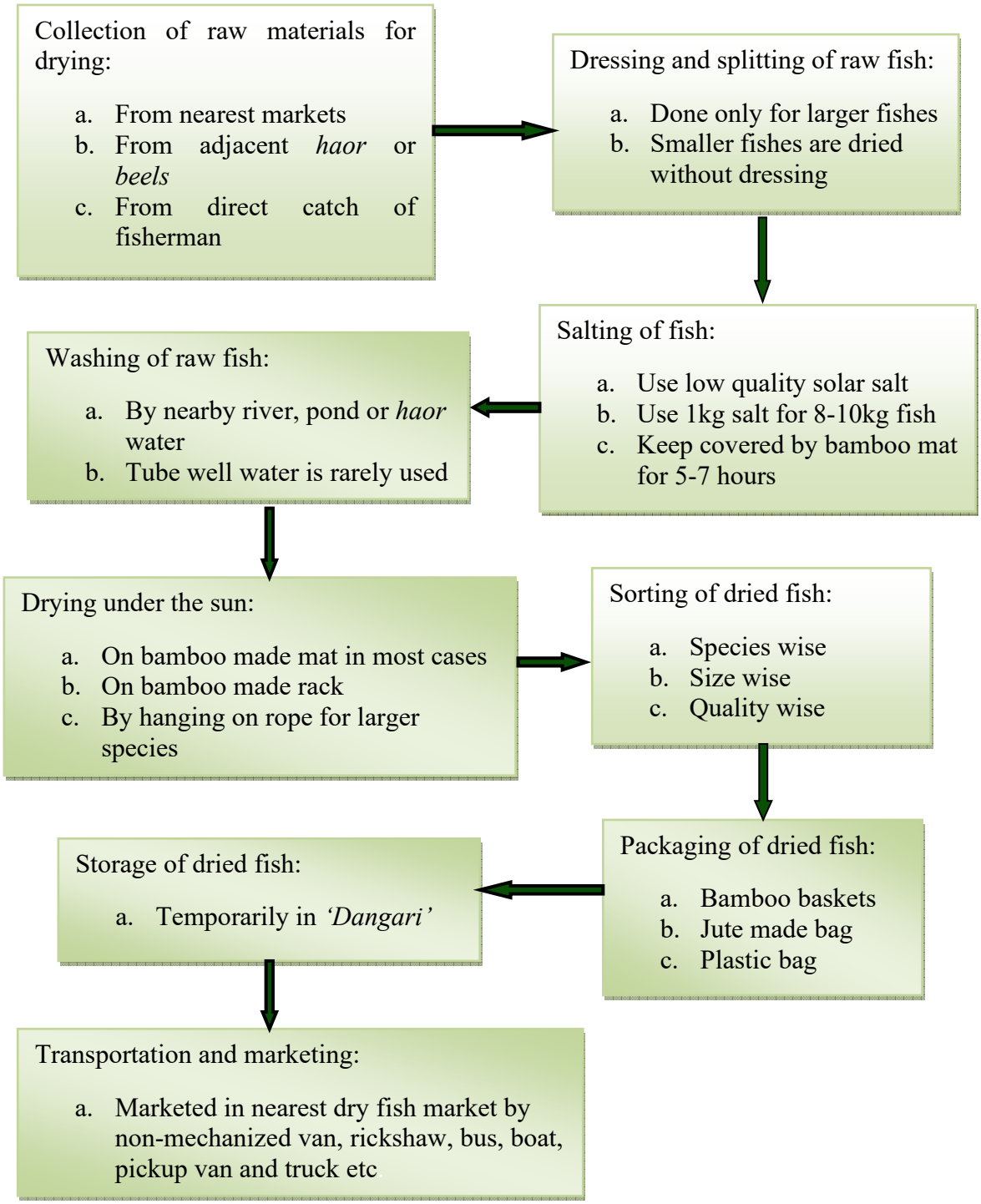

Fig. 4.3 Flowchart for drying activities in Sylhet region

4.4 Production of dried fish

The production of dried fish may vary from area to area and drying points to drying points. Sylhet region of Bangladesh supports huge water resources and a part of huge catch are used for processing of dried fish because of its consumer demand and public preference. Total dried fish production from Tuker Bazar, Mahtabpur and Amtoli of Sylhet district are 73766.64 kg, 201666.6 kg and 9166.68 kg which is shown in Fig.4.4.

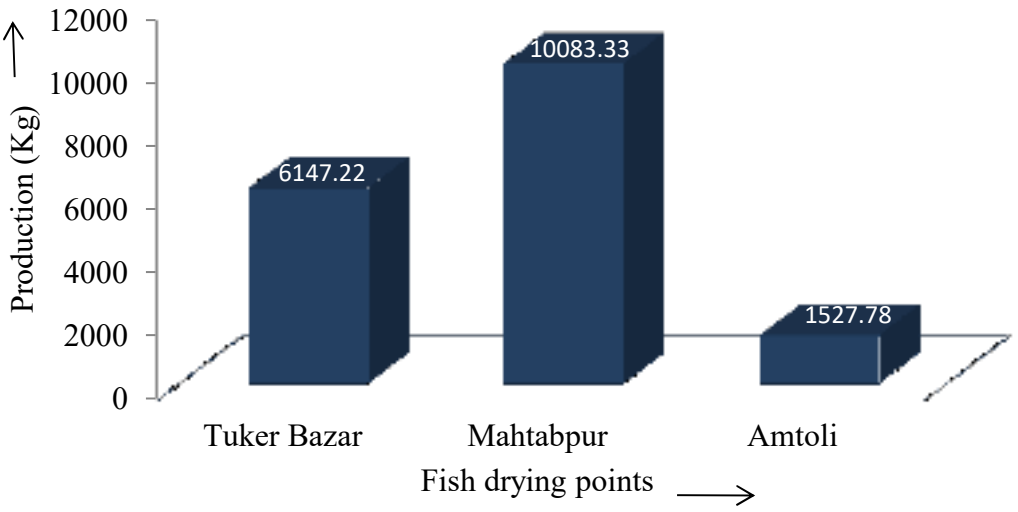

Fig. 4.4 Mean monthly production of dried fish in three drying points in Sylhet region

The fluctuation of dried fish production in different months is shown in Fig 4.5. The dried fish production was always higher at the Mahtabpur area followed by Tuker bazar and Amtoli area.

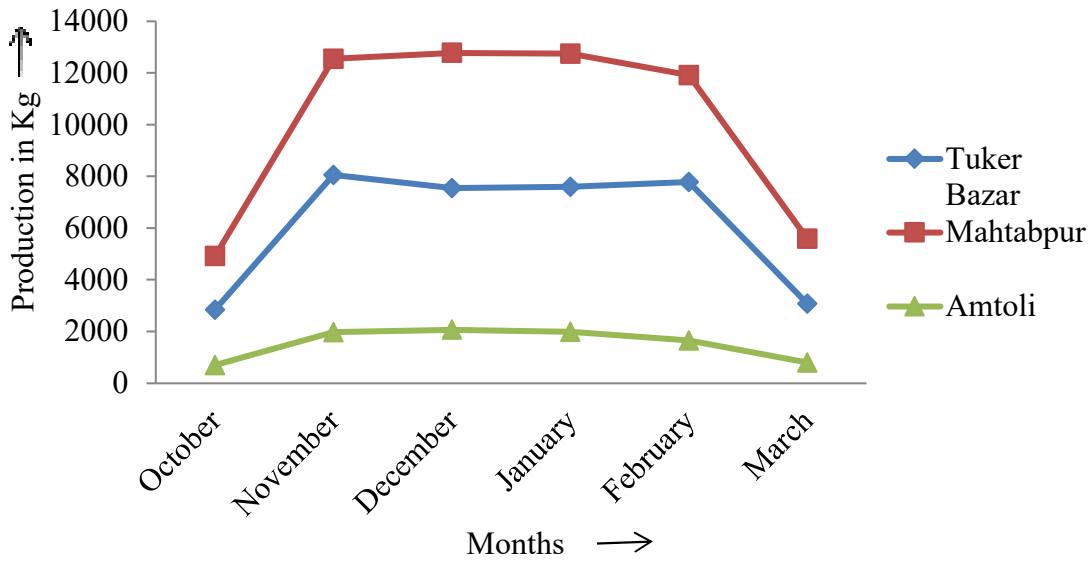

Fig. 4.5 Average dry fish production in different months at three fish drying points

The mean values of different production particulars are presented in Table 4.2. The mean values of area for a single 'Dangari' at Tuker Bazar drying point is 32.80 decimal, whereas in the Mahtabpur and Amtoli are 34 decimal and 14.6 decimal, respectively. There were engaged on an average 9, 13 and 5 nos. of manpower in Tuker Bazar, Mahtabpur and Amtoli drying area, respectively. There are significant differences among the area of drying yards at Amtoli and other two points but there is no significance difference between Tuker bazar and Mahatabpur area. There are also differences in manpower involved in the drying points. In Tuker Bazar drying point, average 117440 kg raw materials were used where the production of dried fish was 47120 kg spending Tk. 200000. Besides, In Mahtabpur drying point, on an average 165500 kg raw materials used and the production of dried fish was 63600 kg and drying cost was Tk. 328000. In case of Amtoli drying area, average 23200 kg raw materials were used for the production of 9260 kg dried fish and the cost was Tk. 25160. There are significant differences among the total production of dried fish among three study areas (Table 4.2 and 4.3).

Table 4.2: Different particulars of fish drying in study areas during study period

Particulars	Tukur Bazar	Mahtabpur	Amtoli
Area of drying yards (Decimal)	$32.80^{a} \pm 2.78$	$34^{a} \pm 4.06$	$14.6^{b} \pm 2.30$
Manpower involved	$8.6^{b} \pm 2.40$	$13.4^{a} \pm 4.67$	$5.4^{b} \pm 1.82$
Amount of raw materials (kg/season)	$117440^{b} \pm 39059$	$165500^{a} \pm 38503$	$23200^{c} \pm 9550$
Total production in different drying points (kg/season)	$47120^{a} \pm 13970$	$63600^{a} \pm 16009$	$9260^{b} \pm 3441$
Total cost in different drying points (Tk./season)	$200000^{a} \pm 101980$	$328000^{a} \pm 127750$	$25160^{b} \pm 8777$

* Mean± SD, P< 0.05, letters in the superscripts indicate significance difference, SD indicates Standard Deviation

Table 4.3: ANOVA on different essential particulars of fish drying in different sites

Particulars	Sum of Squares	df	Mean Square	F	Sig.
Average area (Decimal)	1181.733	2	590.867	60.088	0
Average man	162.133	2	81.067	7.871	0.007
Average raw material (Kg)	5.240E10	2	2.620E10	25.361	0
Average total production(Kg)	7.763E9	2	3.882E9	25.135	0
Average total cost (Tk.)	2.311E11	2	1.156E11	12.937	0.001

$P<0.05$

From the ANOVA table, particulars for fish drying show significant difference.

Table 4.4: Mean monthly dry fish production in different months at three study sites

Months	Mean monthly production of dry fish at three points		
	Tukur Bazar	Mahtabpur	Amtoli
October	2838.33 ± 1218.33	4916.67 ±1797.13	698.33±219.13
November	8053.33±3835.24	12550 ±2746.45	1970±690.13
December	7540±3369.66	12783.33 ±3153.04	2066.67±710.20
January	7590±3415.72	12750 ±3218.54	1986.67±770.84
February	7785±3600.49	11916.67 ±3638.91	1650±516.72
March	3076.67±1368.89	5583.33 ±1813.74	795±296.23

The mean monthly production of dry fish in study areas shows significant difference. In October and March, the average production is lower than other months; this is due to the scarcity of raw materials for dry fish production (Table 4.4).

4.5 Women involvement in fish drying activities

Female workers are also give monetary support to their families through engaging themselves in different types of works of fish drying activities. Most of the women are middle aged and have taken up this profession to uplift their social and economic status. Mostly the widows or destitute women came forward than others. The often have young children and brought them in the processing areas. The women workers engaged in fish processing activities in the study area (Plate 4.9).

Plate 4.9 Dressing and sorting of fish under the bamboo rack

They occupy very low level in the social hierarchy. They mainly involved in the dressing of larger species for drying and the sorting of dried fishes. The present finding is supported by Rabbanee *et al.* (2012).

4.6 Labor cost

The labors of drying points get their wages on the daily or monthly basis. Both male and female workers are also involved in drying activities. Most of the male workers work monthly basis. But women work only daily basis. Their wages varied from drying points to drying points. Male workers work 7.00 a.m. to 11 p.m., but female workers work 7.00 a.m. to 4.00 p.m. Females are mainly involved in dressing and sorting activities whereas male workers handle the whole drying process other than dressing and sorting of fish.

The average daily wages of male and female labor in study areas are Tk. 220 and Tk. 70, respectively (Fig 4.6).The average monthly wages of male labor is Tk. 4080. There is a distinct difference in the daily wages between male and female labor. Male labor gets daily 13.75 Tk. per hour but the female labor gets only 7.78 Tk. per hour which indicates gender discrimination.

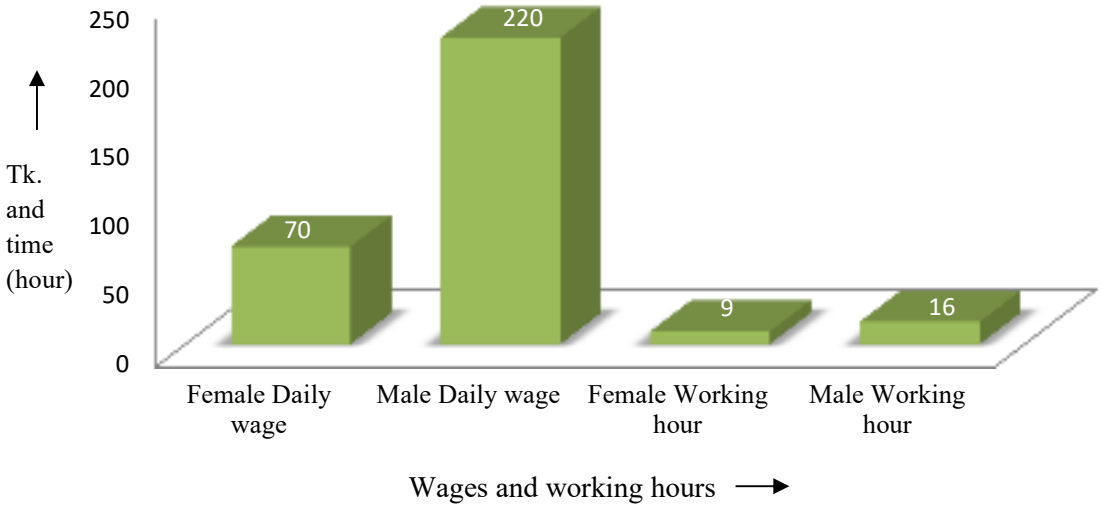

Fig. 4.6 Labor wages and working hours in study areas

The male labors are efficient and engaged themselves in all the activities of fish drying. This difference is due to the differences of working hours. This is due to the social condition of the country. If the social system could ensure equal working atmosphere then there would have no differences. Therefore, the government as well as all member of the society should try their best to do the same. Then the country will be successful from all the sides working together for the development of their motherland.

CHAPTER FIVE

SUMMARY

A study about the status of fish drying in two upazilas of sylhet district was conducted covering Tuker Bazar, Mahtabpur and Amtoli areas for a period of 5 months from October 2012 to March 2013. The present study is focused on the fish drying activities by physical verification and questionnaire interview to the dry fish farmers of study areas.

The Sylhet region of Bangladesh contain largest wetland ecosystem in the north eastern part of our country. It supports huge amounts of fisheries resources. As huge quantity of fresh fish caught every day that remains unsold because of shortage of fresh fish consumers. Fish drying is an age old practice and was adopted as a practical method of preserving fish that have not been immediately consumed or sold in the fresh market. In Bangladesh, sun drying is the most widely used and the least expensive method for fish preservation. Dried fish is an important source of protein in Bangladesh and it is relished by many people of coastal, central and north-eastern districts.

In the study areas, about 23 species were used for drying purpose and most of them were smaller in size. Drying activities generally starts from mid- October to mid- March. About 26.31%, 28.94% and 44.73% dried fish processors were found in the income range of 10000-75000 tk., 100000-500000 tk. and 600000-1000000 tk.

Raw fishes were collected from nearest fish markets or adjacent *haors* by non-mechanized van, rickshaw, boat and bicycle or by head load or shoulder load. Immediate washing, gutting, scaling of fish were not common in the study areas. Non brand and poor quality salt is used to the fish. After 5-7 hours, then the fishes were used to wash by river, pond or *haor* water for the removal of salt. Traditional sun drying method is applied to process the fish. Drying can be done over the bamboo made mat and rack. At normal weather, the drying duration was recorded as 2-6 days depending on the size of the raw fishes. Packaging of the dried fishes can be done by plastic and jute made bags, bamboo baskets for easy storage and transportation to the dry fish markets.

Marketing channels of dry fish includes Dry fish farmers, aratdar, wholesaler, retailer and consumers. Local vendors can also sell the product directly to the consumers.

The mean area of drying yards at Tuker Bazar, Madhabpur and Amtoli were 32.80±2.78, 34.00±4.06 and 14.9±2.30 decimal, whereas the average manpower were used 8.6±2.40,

13.4±4.67 and 5.4±1.82 persons. The mean production per yards at Tuker Bazar, Madhabpur and Amtoli were 47120±13969.50, 63600± 16009.37 and 9260±3440.64 kg respectively against mean raw material 117440±39058.52, 165500±38503.25 and 23200±9549.87 kg and mean cost 200000±101980.39, 328000±127749.75 and 25160±8776.56 Tk. A remarkable number of male and female workers were involved themselves in fish processing activities for drying. The mean daily wages of male and female labors were Tk. 220±78.74 and 70±12.82 seems gulf of difference apparently. However, the real income per hour is nearly same. This difference is due to the differences of working hours. This is due to the social condition of the country. If the social system could ensure equal working atmosphere then there would have no differences.

In Bangladesh, traditional drying is often rudimentary and good hygiene is rarely practiced. During the cloudy weather, when humidity levels are high, sufficient drying cannot be achieved using traditional methods and in such conditions, stored dried fishes reabsorb moisture and become susceptible to bacterial, fungal or insect attack. Besides this, it is well known that, fish is an extremely perishable food commodity and there is no other kind of food observed which have so serious loss at every stage from harvest to consumption. To improve the existing condition it is necessary to understand the present status of drying activities.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

From the study it is clear that the fish drying in two upazilas of Sylhet district is traditional. As it is relished many people of the country and there is a huge scope of its improvement especially in these areas. For the improvement of sun drying in Bangladesh, high cost- involved sophisticated equipment based technology is not required. Much of improvements for good quality products and higher storage life can be achieved by developing practices for maintaining proper sanitation and hygiene in processing area, protecting contamination and introducing adequate packaging. For improved quality dried fish, easy operable low-cost solar dryer can be constructed with cheap locally available materials. Following recommendations should be taken for the improvement of traditional sun-drying process has been discussed below:

1. Traditional fishermen and processors should be trained up on improved sun-drying, sanitation and public health aspects;

2. Premium quality fresh fish should be used for drying. Spoiled fish those are unsellable in the market as wet fish should be rejected;

3. Good handling of raw material vessel should be ensured;

4. Cool chain management of fresh fish should be practiced;

5. Good quality water should be used for washing of raw materials;

6. Clean space and containers should be used during landing and pre-processing;

7. Care should be taken during handling and processing;

8. Use of clean mats, racks and cutting utensils should be ensured;

9. Each and every utensil should be washed after each operation;

10. Gutting and gilling of larger fish should be done properly;

11. Dried fish processors should be concerned about their personal hygienic matters;

12. Elevated multi-staged or plain racks made of split bamboo or used fishing nets should be used for fish drying. Larger fish should be hung on the bamboo frame. Racks can be covered by nets to protect fish from flies, insects and birds;

13. Use of insecticides and agricultural pesticides in fish drying should be stopped completely;

14. Product can be made soft and tender by soaking fish in brine or keeping several hours with good quality contamination-free solar salt (8-10% salt with adequate icing for 6-8 hours);

15. First time used salt should not be used for second time in next batch of fresh fish;

16. Fish should be dried adequately to lessen the moisture content below 16%;

17. To protect it from insect infestation, a mixture of red pepper and turmeric can be used in dried fish;

18. Dried fish should be stored in a hygienic cool and dry environment;

19. Recently developed low-cost emergency fish dryer can be used in absence of sunlight.

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APPENDICES

Questionnaire for dried fish processors

General Information:

1. Name:
2. Involvement in drying work [give tick (√) marks]
   Full time Part time Occasional

   ☐ ☐ ☐
3. Socio- economic information:

Age (years)	**Family size**	**Gender** Male- 1 Female- 2	**Marital status**Married- 1 unmarried-2 widow-3 divorsy-4	**Education** Can sign and count -1 1-5 years school-2 6-10 years of school -3 SSC & above- 4	**Alternate Occupation** 1- Agriculture 2-Businness 3-Daily labor 4-Others (specify)	**Annual Income (Tk.)**

4. How many times you engaged in drying per 24 hours?
5. Drying season (mention the months)

Pick season	Less pick season	Off season

6. What is your work during off season (when weather is not suitable)?

Farming Agriculture	Business	Day labor	Nothing did	Others (specify)

7. What amounts of fish you dry per lot?
8. How many days you engaged in drying in a season?
9. Which months were most favorable for fish drying?
10. Which fishes are very suitable for drying now?
11. Which fishes are mostly rare for drying now in this area?

12. What type of change in quantity of fish drying condition have you observed during the last 5 years?

Same	Decreasing	Increasing

13. If quantity is decreased please mention the reason you think.
14. What are the problems you face in drying of fish?
15. What are the problems you face in marketing of fish?
16. How many times is needed to dry the fishes in a batch?
17. Where from the fresh fishes are collected for drying purpose?
18. What is the marketing channel of dried fish in Sylhet?
19. Mention the total amount of dried fish production in 2012-2013

Monthly (kg)	Yearly(kg)

20. Mention the drying cost in 2012-2013

Monthly (Tk.)	Yearly(Tk.)

21. Mention the income from fish drying in 2012-2013

Monthly (Tk.)	Yearly(Tk.)

22. How many '*Dangaries'* are present in this area?
23. What are the heights of bamboo made rack?
24. What are the dried fish transportation systems?
25. What is the wages for labor?
26. Either salt is used or not.
27. What is the amount and type of salt used for fish?
28. Either sorting or dressing is used or not after collection of raw fish.
29. What is the source of water for washing?
30. Do you use any substance for the preservation of dry fish?
31. If used, then how long it can be preserved?

32. Do you continue fish drying in rainy season?
33. What are your activities when fungus or Beetle attacks on dry fish?
34. What is the hygienic condition there?
35. Mention the preservatives are used in dry fish.
36. Is cool chain management of fresh fish is done here?
37. Is Nobbing and washing is done here?
38. How many people involved in fish drying activities?
39. What are the total populations in the study area?
40. Are you happy with present production?

Happy	Moderately happy	Unhappy