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FARMING PRACTICE IN A FLOODPLAIN VILLAGE OF ASSAM (INDIA): CONTINUITY AND CHANGE

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ABSTRACT

Farming practice in a floodplain environment holds great ecological, economic and social significance. In many cases, agriculture is modernized without caring much for the local environmental conditions. The traditional farming practices, although relatively less productive, are more often than not eco-friendly and sustainable. This paper attempts to study the farming practices followed in a floodplain village of the Brahmaputra valley, Assam, India in terms of cropping practice, inputs and crop protection measures, methods of harvesting and threshing and changes in cropping technology. The study is based on (i) primary data collected from all the 408 households of the village through a purposively designed survey schedule, (ii) interviews with selected farmers and other local knowledgeable persons, and (iii) field observation made by the authors. The data and information thus generated have been summarized using simple statistical and cartographic tools. The study reveals that the farming practice in the village is still traditional in nature with little application of modern inputs and implements. The small size of landholding and scattering of plots and very limited diversification of the rural economy hinder the process of modernization of the farming practice.

Keywords: farming practice, floodplain village, traditional farming, sustainability, cropping technology

INTRODUCTION

The Brahmaputra Valley in Assam (India) is one of the important river valleys of the world where agriculture continues to be the mainstay of the economy. Out of the total working force of the valley, 52.96 percent (as per 2001 census) are engaged in the agricultural sector. Extending for a length of about 720 km from east to west and with an average width of 80 km, the valley is a major

natural unit of Assam. It comprises the elongated north and south bank foothill belts, extensive built up plains and active floodplains including the most sensitive sandbars (*charlands*) and are characterized by variable soil, weather, water and flood conditions. All these together along with the needs and aspiration of the people have given rise to distinctive agro-ecological systems within it.

The agricultural landscape of the valley is the manifestation of small and fragmented landholdings, subsistence type of farming and a very low level of technology application [*Bhagabati and Dutta,* 2001]. For centuries, agriculture had been practiced based on the local resources and indigenous knowledge that were nurtured traditionally. The small farms, wherever they may be, become genetically diverse with a robustness and resilience to adjust to the changing climate, pests and diseases [*Altieri,* 2009]. Except for the large scale commercial tea plantations, the technologies used in crop cultivation in the Brahmaputra valley have been highly traditional. The agriculture in the floodplain villages of the valley is characterized by the dominance of foodgrains and fibre crops (mainly jute) and peasant mode of farming system which also includes the traditional livestock rearing and fishing. However, the advent of green revolution after mid-1960s started influencing slowly the valley's age-old agricultural system. Moreover, the rapidly growing population due primarily to immigration from East Pakistan during and after 1950s on the one hand, and the implementation of rich-biased development programmes and the changing economic and political situations on the other, have notably weakened the traditional organic agro-ecosystem in the valley.

The most deplorable point in this regard is the fact that the depletion of traditional cropping technologies has caused a gradual disappearance of certain important local crop varieties as well as some indigenous agricultural tools from the agricultural scene of the valley. The mechanized agriculture that heralded the green revolution has proved to be a mixed blessing for mankind – an unprecedented growth of crop output and a damage done to the self -sustained traditional agro-ecosystem [*Sinha,* 2004]. During the last few decades, interest in sustainable agriculture has grown worldwide with various sectors of society slowly realizing that resource scarcity, environmental degradation, population growth, uncontrolled economic growth and / or stagnation, social marginalization, etc. have been seriously threatening the long- term limits of agricultural expansion [*Altieri,* 1989].

Several studies on cropping pattern and farming system in the Brahmaputra valley have already been appeared, among which the works of [*Das*, 1984; *Das*, 1992; *Bhagabati*, 1990; *Bhagabati and Das*, 1992; *Bhagabati*, 1997; *Bhagabati*, 2007; *Bhagabati and Dutta*, 2001; *Ando et al.,* 2008; *Deka et al.,* 2009] are noteworthy. However, detailed micro-level studies on the present status and changes in cropping technology are still lacking. A holistic study in this respect is

the need of the hour for further research in the field and extension work .With this rationale behind, the present study attempts to study the continuity and change of the farming practices and investigate the recent changes in cropping technology in a village called Muktapur within the broad geographical framework of the Brahmaputra valley, Assam.

THE METHODS

The farmers of Assam belonging to various communities inhibit different ecological settings ranging from floodplains to hill slopes. Located in the Brahmaputra floodplain environment and inhibited by indigenous community, Muktapur village represents an interesting case so far the history of settlement and the system of farming are concerned. The present farming practice in the village is the result of some degree of modernization over the traditional practices. The village is selected for study as it provides required scopes to investigate the continuity of tradition and intervention of modernity particularly in terms of farming practice.

A comprehensive field work covering all the 408 households of the village was conducted through a purposively designed survey schedule during 2006-2009. The data / information regarding the area under different crops, landholding size and fragmentation of plots, use of fertilizers and pesticides and agricultural implements generated through the household survey have been summarized and analysed. With the help of Participatory Rural Appraisal (PRA) and oral interviews conducted among some old and experienced farmers, the methods of harvesting, threshing, storage and water supply, crop protection measures, preparation of seed-bed as well as the perception of the farmers on the changing agricultural technology in the village have been studied. Personal field visit was made to have an understanding of the traditional agricultural knowledge adapted to the agro ecological settings. Necessary secondary data on agricultural working force, use of agricultural inputs and implements have been collected from Revenue Circle Office, Census Office, Directorate of Agriculture, etc.

The detailed agricultural land use map has been prepared on the basis of the *dag* map collected from the Revenue Office. *Dags* are the smallest land units of the village landscape which are generally demarcated by the village surveyors using some numbers. With the help of the owners of the concerned *dags*, these are again divided according to the subsequent fragmentation of the plots. The data/ information regarding the cropping pattern, land classes, land use change and flood-level have been generated for each of fragmented *dags* in consultation with the owners practically in the field. Mapping tools and softwares such as GPS, ArcGIS 9.2 were also used to prepare the land use map of the village.

The Study Area

The present study is concerned with a village called Muktapur under Goreswar Revenue Circle in Kamrup (rural) district, Assam (Fig 1). The village lies within $26^0 25' 6''$ N to $26^0 26' 1''$ N latitude and $91^0 43' 14''$ E to $91^0 45' 6''$ E longitude. This is a typical village of Assam inhabited by indigenous non-tribal Assamese people. It is located in the north bank floodplain of the Lower Brahmaputra, about 35 km from Guwahati city and 40 km from the Bhutan Himalayan foothills on the north. The Muktapur village covers an area of 3.67 sq km with a total population of 2080 (as in 2006). Out of the total working force of the village, nearly 80 % is directly related to agriculture. The total number of households in the village is 408, out of which 78.92 % have agricultural land while 21.16 % have no agricultural land. This village, representing a flat alluvial plain of the Brahmaputra valley, is a micro agro-ecological unit characterized mainly by food-grain farming (primarily rice), cash cropping, fishing, traditional homestead gardening and livestock rearing. The agricultural land-use pattern of the village evolved through the long-continued nature-culture interaction within the floodplain environment of the valley is really interesting to note (Fig 2).

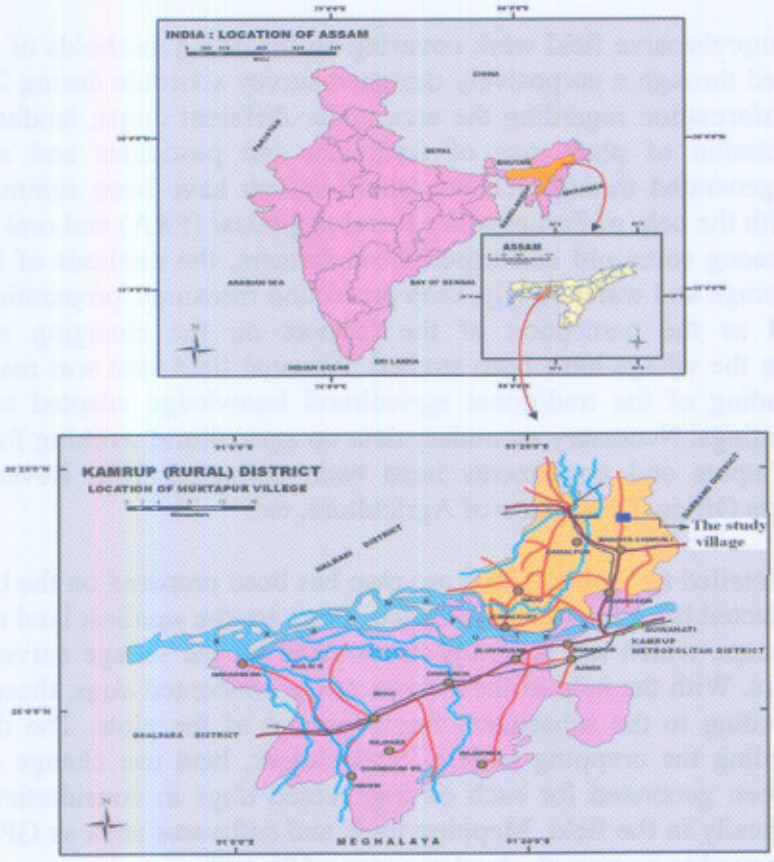

Figure 1. Location of Muktapur village

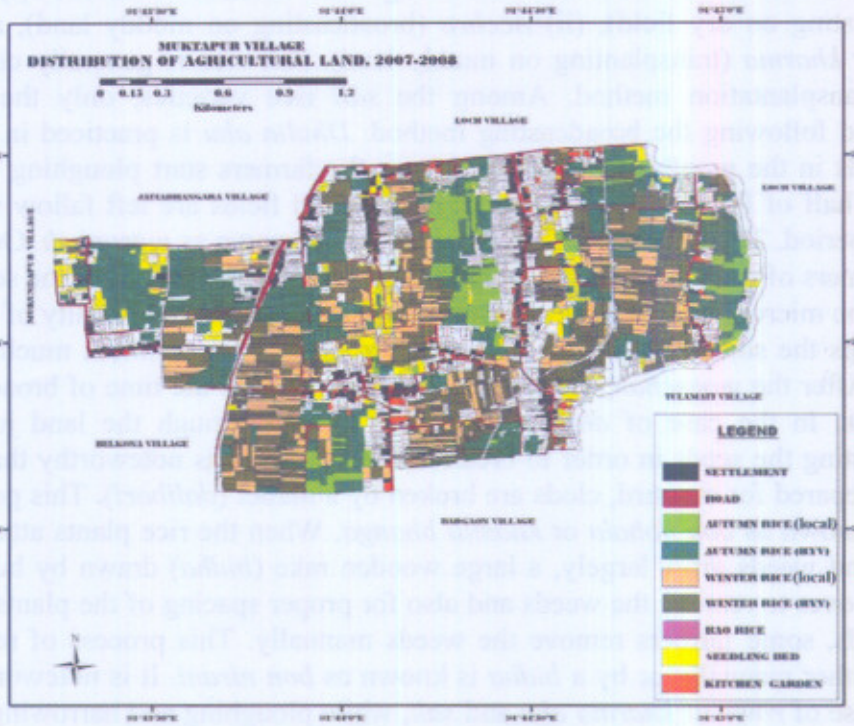

Figure 2. Agricultural land-use pattern of Muktapur village

RESULTS AND DISCUSSION

Cropping Practice

The cropping practice in the village, as in the case of many other monsoon areas of India, is basically associated with the seasonal climatic changes. Based on the local ecological conditions, relative height of lands, natural fertility of soil, availability of water, economic condition of the farmers, demands of food, and other requirements, local tradition, the villagers produce different varieties of crops. *Kharif* (summer) and *rabi* (winter) are the two main cropping seasons. Among the *kharif* crops, rice is the most dominant one which is practiced using both traditional and modern methods. Rice covers 75% of the net sown area of the village. Three different groups of rice are cultivated according to the soil condition and availability of natural water. They are winter rice (*Sali dhan*) cultivated in the low lands (*da mati*) where flood water rises upto 0.53 meter, autumn rice (*ahu dhan*) cultivated in intermediately low lands (*madhyam mati*) where flood water attains a depth of 0.35 meter, and *bao* rice (*bao dhan*) cultivated in very low lands where flood water goes up to 0.88 meter during summer.

Autumn rice is cultivated following three different methods: (i) *Dhulia* (broadcasting on dry field), (ii) *Acchra* (broadcasting on muddy land), and (iii) *Rowa* or *kharma* (transplanting on muddy land). *Sali* rice is generally cultivated using transplantation method. Among the *sali* rice varieties, only the *bao* is cultivated following the broadcasting method. *Dhulia ahu* is practiced in the *sali* rice fields in the month of March. However, the farmers start ploughing lands in the first half of February and the roughly ploughed fields are left fallow upto the sowing period. This process of ploughing is locally known as *marachah.* Out of the total farmers of the village, 87 % adopt this practice in order to make the soil loose so that the micro-organisms can multiply to enhance the natural fertility of the soil. This helps the soil to absorb the subsequent monsoon rain without much surface runoff. After the *marachah*, the land is again ploughed at the time of broadcasting the seeds. In the case of *dhulia ahu*, some farmers plough the land just after broadcasting the seeds in order to break the soil clods. It is noteworthy that in the fields prepared for mustard, clods are broken by a mallet (*dalibari*). This process is locally known as *bon ubhala* or *khamla bhanga*. When the rice plants attain some height and weeds grow largely, a large wooden rake (*bidha*) drawn by bullock is dragged over to remove the weeds and also for proper spacing of the plants. In *sali* rice fields, some farmers remove the weeds manually. This process of removing weeds either manually or by a *bidha* is known as *bon nirani*. It is noteworthy that in the case of *rowa* or *kharma ahu* and *sali*, while ploughing and harrowing (photo 1), weeds are removed from the field using bamboo or iron weeder or *akra* (*akra* is a tool made of tree branch with a bend in its head) (photo 2).

Photo 1. Ploughing by bullock

Photo 2. Weeding

The *acchra ahu* on the other hand is sown by broadcast method in the muddy fields from the latter half of May to the first half of June. *Rowa ahu* is cultivated by transplantation method which does not differ much from that practiced in the case of *sali* rice [*Allen,* 1905]. At present, the *dhulia* and *acchra* systems of *ahu* rice cultivation are not preferred much by the farmers because of its low productivity. Now the *ahu* fields are put to HYV rice, especially a variety called *baismuthi*. However, some farmers still cultivate *kharma ahu* although its area has been gradually decreasing. Even in the case of *sali* rice, there have been certain changes in the method of cropping. In the recent years, most of the farmers are opting for ploughing by power tiller. Therefore, the time lag between ploughing and planting has been reduced leaving no chance for the land to regain its natural fertility induced by microbes. However, the cropping practice of *bao* rice has remained almost same since long.

The farmers of the village grow many *rabi* crops. Among them, different kinds of vegetables, mustard, black gram, lentil, coriander, sesamum and *khesari* are important. Except for mustard, all other *rabi* crops are cultivated following the traditional methods. Table 1 reveals that nearly 79.88% of the gross cropped area is devoted to grain crops, while only 20.11% is put to non-grain crops such as sugarcane, potato, vegetables, tree crops, etc.

Table 1. Area under different crops in Muktapur, 2006

Crops	Area (in ha)	Crops	Area(in ha)
Rice (*ahu+sali+bao*)	184.87 (74.93)	Tree crops	42.8 (17.35)
Mustard and Rapeseeds	6.69 (2.71)	Sugarcane	0.13 (0.05)
Black gram	1.13 (0.46)	Potato	3.59 (1.45)
Lentil	2.27 (0.92)	Vegetables	2.12 (0.86)
Coriander	1.33 (0.54)	Jute	0.32 (0.13)
Kala (*khechari*)	0.79 (0.32)	Others	0.67 (0.27)
Gross cropped area	246.71 ha		
Net sown area	152.99 ha		
Cropping Intensity	161.25 ha		

Source: Field survey, 2006-2007

Note: Fig. in the parentheses indicate the percentage to the gross cropped area.

The cropping technologies, local crop varieties, organic manure, herbal pesticides, and indigenous belief and knowledge system that have been used traditionally in agriculture are considered as socio-economically viable and ecologically adaptive. It is noteworthy that the farmers have long been operating their agricultural activities based on the resources available within the village environment. However, the indigenous practices have now been gradually pushed back with the advent of modern agriculture. The haphazard use of modern inputs including pesticides has adverse impact not only on the agro-ecosystem but also on the attitude of the people and the sustainability of their economy. Importantly, the cropping practice followed by the farmers in the Brahmaputra floodplain has a long evolutionary background reflecting the peculiar natural and human environment of the area.

Landholding Size and Fragmentation

The small size of agricultural landholdings that too fragmented and scattered is a peculiar characteristics of the floodplain agro-ecosystem. The number and size of plots are determined by the degree of fragmentation of holdings resulting from the law of inheritance and other historical and socio-economic factors [*Bhagabati and Das,* 1992]. The size and distribution of agricultural landholdings in the village under study shows notable inequalities in terms of fragmentation and scattering of plots (Table 2). The average size of the agricultural landholdings of the village is 0.62 ha. The highest proportion of agricultural land (39.69%) is constituted by holdings of less than 1 ha size which is owned by

79.81% of the total households of the village. On the other hand, the lowest proportion of agricultural land (10.21 %) falling in size class of 2 - 2.5 ha is owned by 2.80% of the households.

Table 2. Size and distribution of agricultural landholdings

Size class (in ha)	Total land (in ha)	No. of households possessing land
0.0 - 0.5	36.51 (15.49)	183 (56.83)
0.5 - 1.0	57.04 (24.20)	74 (22.98)
1.0 - 1.5	46.14 (19.57)	34 (10.56)
1.5 - 2.0	25.44 (10.79)	12 (3.73)
2 - 2.5	27.27 (11.57)	9 (2.80)
> 2.5	43.27 (18.36)	10 (3.10)
Total	235.67	322 (78.92)

Source: Field survey, 2006-2007
Note: Fig. in the parentheses indicate the percentage to the total

The agricultural lands of the village are fragmented and scattered over space rendering inconvenience in implementing modern agricultural practices (Fig 3).The total number of agricultural plots in the village is 1157, of which the highest number of plots (24.72 %) fall in the category of 0.12 - 0.16 ha size. The highest proportion of area (45.19 %) is distributed in only 196 plots of above 0.28 ha size (Table 3), while the lowest proportion of area (1.16 %) is distributed in only 14 plots of 0.20-0.24 ha size. An apparently large agricultural field in the village is thus composed of a large number of holdings with scattered plots of various shapes and sizes.

Table 3. Agricultural plots in different size-classes

Size class (in ha)	No. of plots	Area (in ha)
Below 0.04	124 (10.72)	2.96 (1.26)
0.04-0.08	226 (19.53)	15.45 (6.56)
0.08-0.12	64 (5.53)	7.24 (3.07)
0.12- 0.16	286 (24.72)	40.58 (17.21)
0.16-0.20	81 (7.00)	15.51 (6.58)
0.20-0.24	14 (1.21)	2.74 (1.16)
0.24-0.28	166 (14.35)	44.67 (18.95)
Above 0.28	196 (16.94)	106.52 (45.19)
Total	1157	235.67

Source: Field survey, 2007-2009
Note: Fig. in the parentheses indicate the percentage to the total

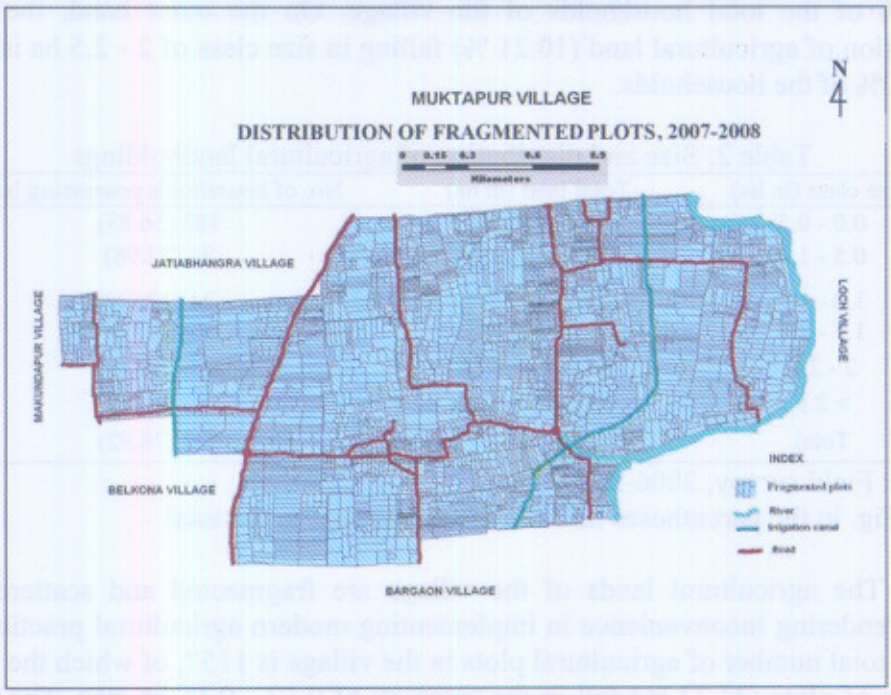

Figure 3. Distribution of fragmented plots

Preparation of Seed-beds

The seed beds for rice are prepared following traditional method (Photo 2.a and 2.b). Usually a suitable plot of the size 0.5-1.0 *katha* (1 *katha* = 0.026 ha) near the homestead or some water source is selected for preparing the seed beds. The land selected is ploughed five times by wooden plough and harrowed six times. Farmers use *kamra moi* (convex side of harrow) for harrowing the land. After supplying required water to the soil, *lota moi* (concave side of harrow) is used to make it smooth. Again water is supplied to the plot from nearby *khal* or pond using a *sichani* or *lahati*. The water is distributed all over the plot uniformly with the help of a *sichani*. Before sowing, the seeds are kept in a *topa* or *thali* and steeped in ponds or *khal* for at least one night and then these are stored in a cool dark place. The seeds are covered with blue arum leaf or banana leaf so that they germinate easily. The germinated seeds are then broadcast by hand in the land already prepared. When the plants attain a height of 20 – 30 cm after 20-25 days these are carefully uprooted from the nursery bed and carried in bundles to the field prepared for transplantation.

Photo 2.a. Preparation of seed-bed

Photo 2.b. Uprooting seedlings from seed-bed

Sometimes because of flood, the seedlings may not be transplanted in time. In such a situation, the seedlings are removed from the nursery beds and planted very thickly in larger bunch in another suitable plot. These transplanted seedlings are called as *joa kathia*. This kind of transplanted rice is said to be unusually strong and more productive [*Allen,* 1905]. The *joa kathia* is again uprooted for final transplantation in the prepared fields as soon as the flood subsides.

Application of Fertilizer and Crop Protection Measures

It is worth mentioning that before 1990s the farmers of the village applied some indigenously prepared bio-fertilizers (Photo. 3) and pesticides (Photo. 4) in their agricultural fields. During those days the farmers used to carry cowdungs to the agricultural fields all throughout the year. The domesticated animals were also set free from the month of *Magh* (January) to *Chait* (March) to graze in the harvested fields and thus the rice fields used to receive enough of dungs and urine. Earlier, most of the farmers practiced double and triple cropping particularly in the

ahu fields and kitchen gardens in order to get all necessary agricultural commodities. In the *acchra ahu* fields, the farmers practiced triple cropping. Just after harvesting *ahu* rice, farmers cultivate *sali* rice in these fields. Again, when the *sali* rice plants attain sufficient height and the grounds are dried up during September – November, farmers sow seeds of *khesari*, black gram and green gram in the rice fields as intercropping. In the case of *kharma ahu* fields, after harvesting *ahu* rice, fields are put to mustard and coriander. Thus the practice of multiple cropping reduce the cost of and time for field preparation, cause effective use of moisture residues in the paddy fields and utilize the prevailing micro-climate of the standing paddy crops for successful germination of subsequent pulse seeds [*Immannuel et al.,* 2010]. Also, these leguminous crops enhance soil fertility by fixing nitrogen in the soil. It is noteworthy that farmers of the village harvest rice manually, which does not affect the seeds already germinated over the ground. Such a practice of crop rotation, which enhances soil nutrition and reduces attacks of diseases and weeds for the subsequent crop, constitutes an important organic crop management activity traditionally pursued by the farmers. The practice of crop rotations preserves larger diversity of species, soil macro and micro fauna and thus sustains ecological balance.

Photo 3. Application of bio-fertilizer

Photo 4. Indigenous crop protection measure

In addition to these, most of the farmers of the village leave the residues of certain crops in the fields after harvesting. The use of compost, cowdung, oil cakes, twigs of crops etc in the field has been an age-old practice still followed by most of the farmers. This practice helps conserve the soil moisture and improves structure and fertility status of soil through decomposition of mulches during rainy season [*Immanuel et al.,* 2010]. After 1990s, some farmers started using HYV crops, chemical fertilizer and pesticides in order to increase the crop yield level.

So far the protection of crops from insects and pests is concerned, farmers applied some age-old practices. Farmers used wood-ash on foliage of crops like chili, onion, potato, bringal, lady's finger, cucumber, etc. Wood-ash particles act as a mechanical hindrance to insects and may also help by desiccating the fungal spores and insect's eggs [*Sinha,* 2004]. Another common practice for controlling diseases and insects was to apply the leaves or branches of certain medicinal plants such as *pasatia* (*Vitex negundo*) and *mahaneem* (*Azadirachta Indica*) in the paddy fields. Some farmers also throw pieces of citrus fruits, fresh cow dung, oilcake, lime etc. on the crop foliage. To use as a good deterrent for rats or rodents and insects, farmers left dead snakes in the fields to decompose. Farmers also used to hang rotten crabs (*Kekora*) in the paddy fields so that its smell could attract insects and deviate them from the targeted crops. In addition, some farmers put lamps in the fields at night to attract and kill insects. In order to drive away the rodents from the field, farmers identified the rat holes and chunk them except the one through which they would pour water. The rats inside thus get suffocated and die. Again, for driving away the birds and rodents from the fields farmers even to-day tie some colorful ribbons and polythene strips around and across the fields. Another means to drive away birds from the crops is by placing a false human figure in the field.

Method of Harvesting, Threshing and Storage

The method of harvesting rice (Photo 5) continues to remain traditional inspite of remarkable changes in this sector of economy. When rice becomes mature, the farmers make necessary preparation for harvesting. They cut the rice plants off at about 20 cm from the top. One or two plant strings are used to tie up the reaped rice plants and then left the bundles to dry over the stiff stubble for one or two days. When the grains dry up, the bundles (*muthi*) are put together to form a *dangori* (bigger bundle). A *dangori* contains a few *japs* (six smaller bundles form a *jap*). And two such *dangoris* form a *bhar*. Two *dangoris* of equal size are connected by a strong bamboo bar called *hulabari* and thus the pair of load is carried home manually. In this way harvested rice is brought home from the fields located sometimes at a distance of more than a kilometer.

Photo 5. Harvesting of rice

Rice is threshed systematically after they are carried home. Threshing is generally done by pairs of the bullocks making them walk over the heaps of rice bundles kept on the courtyard. This practice is called *marana mara* (Photo 6). The sheaves of rice are spread in a circular manner over the courtyard. Tightened parallelly 3 to 4 bullocks are driven over the heaps of rice for several rounds until the seeds get completely separated from the stalk. While taking the bullocks over the heap, a bamboo hook (*okhon*) is frequently used to mix the grain bundles. When the grains get separated from the stalk, these are then collected by a wooden shovel (*raina*) and by broom (*bahrani*). The grains are then passed through a sieve and jerked in the air by a flat bamboo tray (*kula*) so as to remove the chaff from the grains. The grains are then stored in a granary (*bharal ghar*) or in a huge container (*duli* or *pasi*). The *bharal ghar*, *duli* and *pasi* are made of split bamboo plastered with a mixture of mud, fresh cow dung and rice husk. Over the stored grain, a layer

of blighted grain or ash or *neem* leaves are put to protect the grains from pests and insects. The seeds, which are preserved for subsequent sowing, are kept in loosely plaited bamboo baskets (*topa*) wrapped around with rice straw. This is the way the villagers traditionally protect the seeds from all probable damages.

Photo 6. Threshing (*Maranamara*) by pairs of bullock

Methods of Supplying Water

The farmers of the village still solely depend on the erratic monsoon as they lack modern irrigation facility. They carry water form the nearby ponds and *khal* to irrigate mainly the vegetables and other horticultural crops. During monsoon (June-August), the winter rice (*sali dhan*) fields are flooded upto a level of 0.53 meter, while in the autumn rice (*ahu dhan*) fields, the flood water attains a height of 0.35 meter. Most of the farmers dig out very small and shallow ponds in the corner of their *sali* fields so as to retain the excessive summer water. Again, to retain the rain water in the fields, farmers prepare dykes around the fields as per the nature of the land. Normally the autumn rice fields are slightly higher than the winter rice fields. Farmers generally make the fields smaller with necessary dykes in the case of autumn rice to retain rain water for a longer period. In an autumn rice field with an area of 1 *bigha* (1 *bigha* = 0.134 ha), for instance, 5-6 divisions (*dobol*) are made with dykes around each plot. In winter rice fields on the other hand, which are usually of smaller size, 3-4 divisions are made. During summer, when fields get flooded, a very small segment of the dykes is removed in such a way that the released water does not affect the standing rice plants in the successive fields. During the preparation of seedling beds, required water is supplied manually from nearby *khal* or pond using a *sichani* or *lahati*. At the time of ploughing and harrowing, the rain water collected here and there in the fields is distributed equally all over the plot with the help of *sichani* (photo 7). Thus, the water in the rice fields is managed traditionally with appreciable co-operation among the farmers sharing a particular field system.

Photo7. Supplying water to the fields manually

Changes in Cropping Technology

The change in cropping technology is associated mainly with three kinds of innovation: chemical, biological and technological. Although the green revolution in late 1960s had introduced remarkable change in cropping technology in many parts of the country, change in this village had not been so much discernible. According to the farmers, change in the cropping technology occurred in the village with the advent of HYV crops and power tiller in the late 1980s.

A statistical statement on the change of agricultural machineries and implements in the village is presented in Table 4. It reveals that there has been a gradual increase in the proportion of the land ploughed by power tiller. In 1986, only 3.99 % of the land was ploughed by power tiller and the rest 95.99 % was tilled by wooden plough. The proportion of land ploughed by power tiller increased to 56.81 % in 2006. The area under HYV crops on the other hand increased from 21.04 % to 55.62% during the period 1986-2006.

Table 4. Change in the use of agricultural implements in Muktapur village during 1986- 2005

Year	Land ploughed (in ha.)		Land under local/ HYV seeds (in ha.)		Land under fertilizer use (in ha.)		Land under pesticide use (in ha)	
	By wooden plough	By power -tiller	Local Seeds (rice and vegetable)	HYV seeds (rice and vegetable)	Organic manure	Chemical fertilizer	Herbal pesticides	Chemical pesticides
1986	224.63 (95.99)	9.37 (3.99)	196.59 (78.95)	52.41 (21.04)	225 (78.28)	62.41 (21.71)	282.67 (98.35)	4.73 (1.64)
1990	215.22 (88.93)	26.77 (11.07)	182.95 (73.46)	66.10 (26.54)	214.73 (74.60)	73.1 (25.39)	274.98 (95.53)	12.85 (4.46)
1995	157.74 (66.54)	79.29 (33.33)	151.85 (63.03)	89.03 (36.96)	173.42 (61.96)	106.43 (38.03)	257.1 (91.87)	22.75 (8.13)
2000	127.74 (60.11)	84.77 (39.88)	114.45 (53.73)	98.55 (46.25)	150.32 (58.93)	104.75 (41.07)	248.38 (97.25)	6.69 (2.62)
2006	87.71 (43.18)	115.41 (56.81)	90.49 (44.37)	113.42 (55.62)	131.02 (53.04)	115.97 (46.95)	226.71 (91.78)	20.28 (8.21)

Source: Calculated on the basis of data obtained from the Circle Office, Goreswar and primary field survey, 2006

Note: The figures in the parentheses indicate the percentage to the total agricultural land.

During the same period, the proportion of area having fertilizer input increased from 21.7 % to as high as 46.95 %. Similarly, there has been a gradual increase in the proportion of land with chemical pesticides from only 1.64 % to 8.21 % during 1986-2006.

It is worth mentioning that because of the growing influence of the innovative technology on agriculture some of the age-old cropping technologies are in the process of gradual disappearance from the village agro-ecosystem [Deka *et al*., 2009]. The practice of weeding called *marachah, bon ubhala*, *bon nirani*, herbal preparation as pesticides, application of organic manure and cultivation of local varieties have been gradually replaced by modern practices. The change in cropping technology experienced by the village during 1986-2006 is presented in Table 5. It is revealed that the seed-beds for rice are still prepared following the age-old methods. Interestingly the frequency of ploughing and harrowing has remained same during the last 25 years. However, some changes in the process of preparation of the paddy fields have occurred. These are now prepared following a combination of the traditional and modern technologies. Table 5 reveals that the frequency of ploughing and harrowing by bullock-drawn wooden ploughs and harrows has come down because of the increasing use of power tillers and tractors. Before 1986, the *sali* rice fields were ploughed and harrowed 4-5 times. Now it is reduced to only once in some cases. So far the traditional ploughing is concerned, the farmers of the village use two types of plough (*nangal*): s*aja nangal* and *buta nangal. Buta nangal* is used for ploughing the muddy fields, while *saja nangal* for the dry fields. In harrowing, farmers use a two-sided bamboo harrow.

Table 5. Change in cropping technology in Muktapur village during 1986-2006

Crops cultivated	Preparation of seed beds		Land Preparation for paddy		Kind of Fertilizer applied		Kind of Pesticides used		Method of weeding	
	Ploughing(P)-Harrowing (H) (in number)		Ploughing (P)-Harrowing (H) (in number)							
	Before 1986	In 2006	Before 1986	In 2006	Before 1986	In 2006	Before 1986	In 2006	Before 1986	In 2006
Winter (*Sali*) rice	P=5 H=6	P=5 H=6	P=5 H=4	P=1 H=1	Cow dung, compost bio-manure, oil cake, twigs	Urea, potash, DAP	Wood ash, Citrus, fruits, lime, oil cake	Malathian, *Ustad, Gamaksin*	Using *Zabaka, Akra,*	Using *Zabaka, Akra*
Bao rice	Nil	Nil	P=5 H=0	P=5 H=0	Nil	Nil	Herbal concoctio, citrus fruits,	Herbal concoctio, citrus fruits,	Using *Zabaka, Akra,*	Using *Zabaka, Akra*
Autumn (*Ahu*) rice	P=5 H=6	P=5 H=6	P=5 H=4	P=1 H=1	Cow dung	Urea, potash	Herbal concoctio, citrus fruits,	Malathian	Using *Zabaka, Akra,*	Using *Zabaka, Akra*
Mustard	Nil	Nil	P=5 H=4	P=1 H=1	Cow dung	Urea, potash	Wood ash, citrus fruits, oil cake	Malathian, Ustad, Gamaksin	Manually	Manually
Potato	Nil	Nil	P=15 H=50	P=15 H=50	Cow dung, Compostbio-manure, cake, twigs	Urea, potash, oilDAP	Herbal concoctio, wood ash, oil cake	Malathian,	Manually	Manually

Source: Interview with the farmers of the village, 2006

No significant change has been observed in the weeding process. Farmers are still using traditional implements like *zaboka, akra, bidha,* hoe, etc for weeding. Notably, the agro-ecosystem of the village has been adversely affected by weather-related uncertainty and risks. The agriculture in the village is basically rain-fed, and so far there is no any kind of modern irrigation facility. Traditional tools like *sichani* and *lahati* are still in use for supplying water to the paddy fields from the nearby water sources.

For harvesting crops and other products, sickle, *hakoti, jakhala* are still used. Indigenous bamboo-made tools like *okhani, bahrani, salani, kula* and *dukula* are applied in threshing operation. However, some farmers have now started using tractors for threshing. No change has been noticed in the method of seed preservation. Farmers still use some indigenous means like *topa, pasi, duli, bosta, bharal ghar* etc. for the purpose of storage and preservation of seeds.

Farmers' Perception on Cropping Technology Change

The farmers of the village are still adopting traditional cropping technologies that are less expensive and considered to be environmentally adaptive [Ando, *et al.*, 2008]. The adoption of new farm technology in the village seems to be low and slow. Generally chemical fertilizer, HYV seeds, pesticides etc. are costly and therefore not affordable to the marginal farmers. Majority of the farmers naturally choose the indigenous cropping technologies instead of the modern innovative measures. The most deplorable point is that unlike the past generations of farmers, the present generation is not interested in practicing multiple cropping. Among the present generation, there are only a few who have opted agriculture as the main occupation. Moreover, the low return from agriculture, general negligence to the farming community, lack of irrigation facility, gradual change in food habit, adoption of HYV and related farming packages are seen to be responsible for the declining trend of intensive cropping during the recent years. Again, there has been a psychological reluctance among the aged farmers towards the use of modern farm technology. They believe that heavy dependence on modern farm technologies would detach the farmers from their long-continued culture of physical involvement with agriculture and as a result, the new generation would fail to inherit the indigenous cropping practices.

The modern cropping technologies are found to be responsible for the disappearance of some local crop varieties as well as indigenous agricultural tools. Moreover, there has been a growing social negligence to the small farmers and the traditional farming activities. As a result, the number of workers engaged in agricultural activities has significantly decreased. All these factors have, however, compelled at least some of the farmers of the village to switch over gradually to mechanized farming.

CONCLUSION

The farming practice followed in the floodplain villages of the Brahmaputra valley is, by and large, traditional with some sporadic minor mechanization. As evident from the study carried out in the village Muktapur, large majority of the farmers, particularly the small and marginal ones, are still adopting the traditional practices which have proved to be effective and sustainable in their local environmental setting. So far the inputs are concerned, most of the farmers apply the age-old practices like applying compost, cowdung and oil cake to increase the fertility of the land. Only recently the farmers have started using chemicals to fertilize the land. The crop protection measures adopted by the farmers are found to be mostly traditional. Wood-ash, herbs, decomposed parts of some minor animals and other man-made devices are used to protect the crops from pests, insects and animals. They also follow the age-old methods of harvesting and threshing of crops and storage of seeds. No modern technology is used in this respect as yet. In tilling lands on the other hand, power tillers are increasingly being used replacing the bullock-drawn wooden plough. Thus, the agro-ecosystem of the village has been influenced gradually by the diffusion of modern farm technology. It is noteworthy that the indigenous cropping technologies continue to remain not only meaningful in the context of the local culture and economy in which these were evolved by the people, but also may be equally important for the development planners in evolving sustainable strategies and action plans for improving the condition of agriculture in the floodplains of the valley.

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