CIMMYT

Prospects and Challenges of Expanding Maize Production in Bangladesh

Prepared and Presented by:

Visiting Scientists

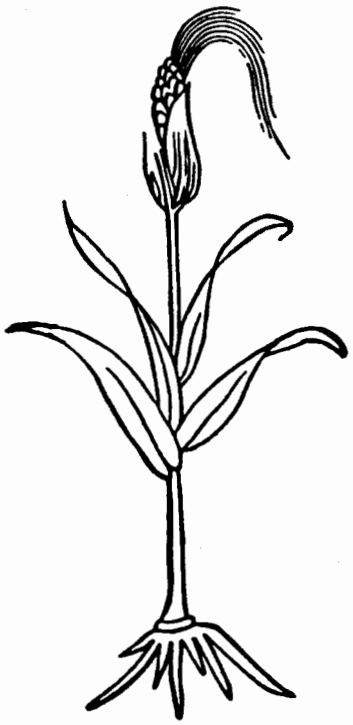
S. F. K. Dewan, M. A. Salam and A. A. Mondal

Bangladesh

May 1998.

CIMMYT

Prospects and Challenges of Expanding Maize Production in Bangladesh



Prepared and Presented by:

Visiting Scientists

S. F. K. Dewan, M. A. Salam and A. A. Mondal

Bangladesh

May 1998.

Introduction

Bangladesh is a unitary and sovereign country known as the Peoples' Republic of Bangladesh. Bangladesh emerged as an independent country on March 26, 1971, and its state language is Bengali.

The geographical location of Bangladesh is on the northern side of the Bay of Bengal. Bangladesh is between 20° 34' and 26° 38' north latitude, and between 88° 01' and 92° 41' east longitude. The area of B. D. is 56977 square miles or 143,998 square km. It has 6 divisions, 64 districts, 490 *thanas*, and 4451 unions, all administrative units. The population of Bangladesh is 120 millions, with equal proportion of peoples are male and females. The annual population growth rate in Bangladesh is 1.7% (1996 census) and it has a population density per sq km of 755 (1991 census). The literacy level of the country is 40% up to 7 years and above. The country has three main seasons winter(Nov-Feb), summer (March-June), and Monsoon (July-Oct). Climatic conditions of the country vary through the year. In winter, maximum temperature averages 29°C and minimum temperature 10°C to 11°C, while in summer maximum temperature averages 34°C and minimum 21°C. In the monsoon temperatures are like in summer, and in the monsoon season average rainfall is 1194mm to 3454 mm.

Bangladesh is called a country of rivers because many many rivers cross the country.

The main crops in Bangladesh are rice, wheat, jute, tea, tobacco, sugarcane, pulses, oilseeds, potato, spices, and vegetables.

Maize is a new crop of Bangladesh

Maize is one of the most important food grains in the world as well as in developing countries like Bangladesh. The food produced in Bangladesh is not adequate to meet domestic requirements. Cropping intensity is already more than 155%, and approaching 200% wherever intensification is possible. However, the yields of most cereals crops are

low. The problem is worsened by massive unemployment of younger people. Thus any agricultural development policy that is not employment oriented is self defeating. Malnutrition is the another widespread problem in Bangladesh.

Although Bangladesh has decreased its annual population growth-rate from 3% to 1.7%, the food problem is still staggering. To meet the challenge, cereal crop production alone would need to be increased by at least 1.5-2.0 million tons per year to bridge the food gap at present levels of production.

Rice has been the traditional source of calories in Bangladesh's rural area but now about 10% of the requirement is being met by wheat. These two crops contribute 95% of the requirement for grain production each year. Any natural disaster dramatically accentuates the problem, severely affecting those with few resources. The government of Bangladesh's policy has been, and still is, predominantly based upon a wheat and rice HYV approach, where high irrigation and fertilizer inputs are designed to balance the food production equation. In Bangladesh more than 40% of the arable land is under irrigation, leaving 60% of the cultivable land as rainfed.

We project then, that to be able to feed the Bangladeshi population at acceptable levels of calories and proteins, in the year 2005 this would require 25 million tons of cereals. Wheat and rice production is not enough to meet the challenge. Other crops and vegetables, particularly those which suit rainfed conditions will have to play an important role. Maize is the first among such crops. It can become the third major cereal crop of Bangladesh. The Government of Bangladesh is how introducing maize cultivation in winter and summer seasons, and we started to actively expand maize production from 1996. Last year around 20 thousand ha. of maize was sown, and this year it may increase to 25,000 ha.

From the agroedaphic point of view, maize can be grown all over the country. It is a fast growing crop. Maize grows well with a minimum temperature of 10 degree C and a maximum 30 degree C. Maize sheds pollen well and matures quickly at a temperature

range from 20 degree C to 30 degree C. The average minimum and maximum temperatures of 12 degree C and 29 degree C, respectively, of Bangladesh are ideal for successful maize production. Being a short day crop, maize can be grown through out the year in all parts of the country.

Maize can be grown under a wide range of soil conditions. It grows best on a fine sandy-loam to a heavy clay-loam soil, and from a moderately acid (pH 5.0) to a moderately alkaline (pH 8.5) soil. Large areas of Bangladesh have mainly loamy soils with a pH range from 5.5 to 7.0, which is ideal for successful growth and development of maize.

Maize has the capacity to thrive under a wide range of moisture conditions (500 mm to 5000 mm of rainfall). It will produce a good yield in favourable conditions and give a reasonably good yield under moisture stress conditions. The rainfall pattern of Bangladesh is erratic, with large falls in the summer and little or none in winter. From the point of view of moisture, maize can be grown throughout the year. Maize being a C4 cereal, is more efficient in converting solar energy to drymatter than most other cereals, and is also very efficient in using water. Moreover, maize is ideal for intercropping and mixed cropping, especially with legumes, potato, onion and groundnuts.

No serious pests (insects or diseases) have been reported on maize in the country (See below, however). However, if and when area and intensity of maize cultivation grow, this situation may change. As of now the absence of pests make it easy to promote maize.

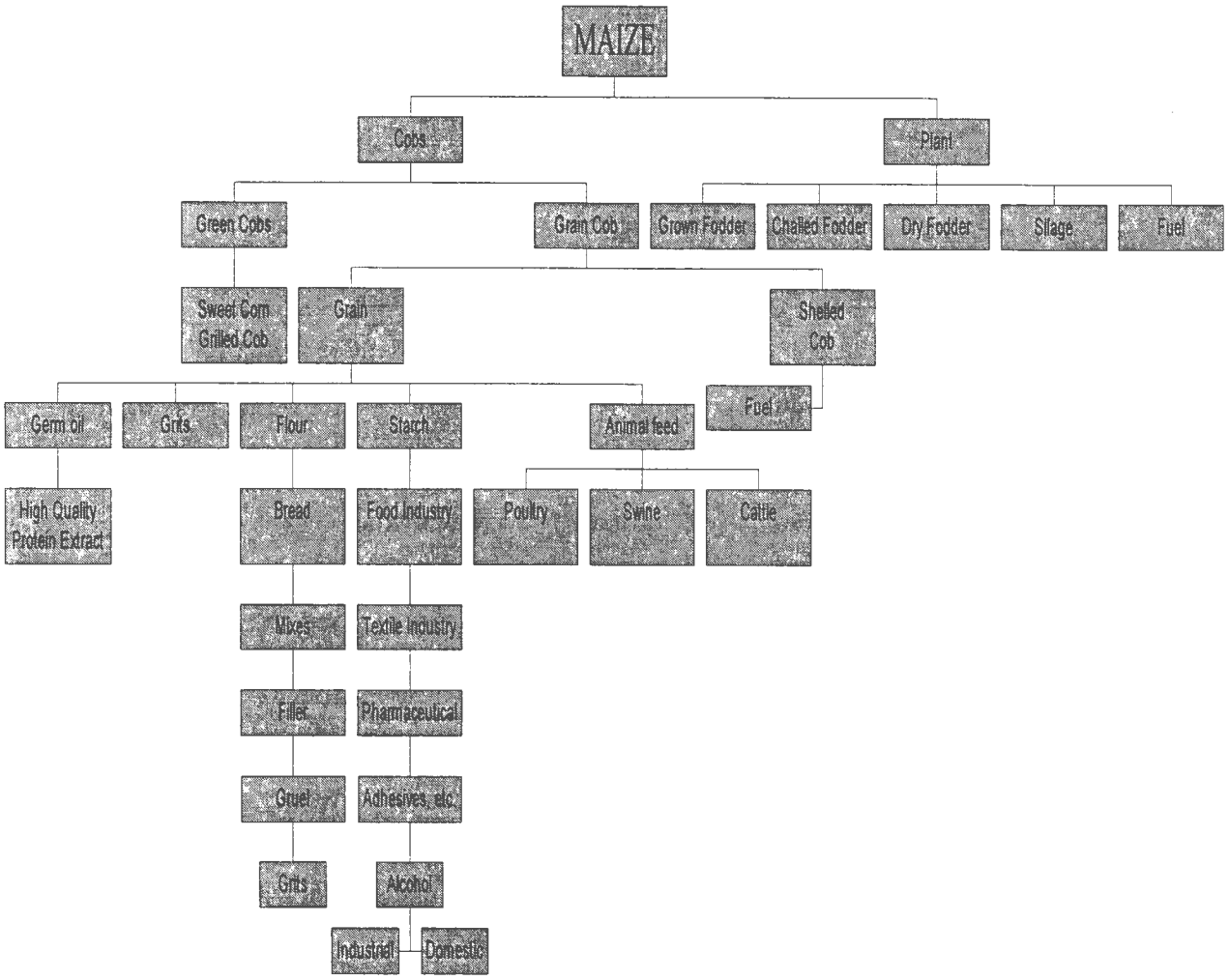
The maize kernel is one of the most efficient capsules of food designed by nature. It is a high energy food having highly digestible carbohydrates for human nutrition, cholesterol free oil, moderate levels of protein and a good quantity of trace minerals.

Maize is fairly rich in vitamin-B and the yellow kernel type is also a good source of pro-Vitamin-A, carotene, which can prevent human blindness. The chemical composition and

comparative nutritive value of maize, wheat, and rice composition per 100 grams are presented below:

	Composition	Maize		Wheat flour	Rice milled
		Dry	Green	(whole)	
1	Energy (Kcalories)	342.0	125.0	341.0	346.0
2	Protein (g)	11.1	4.7	12.1	6.4
3	Fat	3.6	0.9	1.7	0.4
4	Minerals (g)	1.5	0.8	2.7	0.7
5	Fiber (g)	2.7	1.9	1.9	0.2
6	Carbohydrate (g)	66.2	24.6	69.4	79.0
7	Calcium (mg)	10.0	9.0	48.0	9.0
8	Phosphorus (mg)	348.0	121.0	355.0	143.0
9	Iron (mg)	2.0	1.1	11.5	4.0
10	Carotene (mg)	90.0	32.0	29.0	-
11	Thiamin (mg)	0.4	0.1	0.5	0.2
12	Riboflavin (mg)	0.1	0.2	0.2	0.1
13	Niacin (mg)	1.8	0.6	4.3	3.8
14	Vitamin C (mg)	0.0	6.0	0.0	0.0
15	Moisture (g)	14.9	67.1	12.2	13.3

In Bangladesh, maize can be used in different ways as human food. Maize could be a good source of protein, carbohydrate and lipids for the under - and malnourished population of Bangladesh. Possible uses of maize are summarized below.



In Bangladesh, a shortage of cooking oil has reached alarming proportions. Moreover, most of the available cooking oil is not of high nutritional value. Production and use of maize oil could help alleviate this situation, and the by products of oil extraction can also be used in bakery products.

Animal feed in the country is severely deficient due to the lack of an organized feed industry and non availability of grazing land. Thus, maize could play an important role as animal feed and fodder fed as stover, green fodder or as silage. One of the important attributes of maize is that even after the cobs are harvested the remaining plant can be utilized as fodder. Thus maize would provide food for humans and feed for the livestock from the same planting and with the same input costs.

Maize is also an excellent poultry feed. Yellow maize provides an additional advantage since it contains the fat soluble vitamin -A precursor, carotene, needed to promote normal growth in animals. At present poultry farmers are importing 2500 tons of maize grain per year for the poultry industry, thus expending valuable foreign exchange. No doubt, maize production in the country would reduce the drain of foreign exchange and at the same time contribute to the growth of the poultry industry.

Mature, dried maize stalks can also be used as a fuel for cooking in the rural areas. Electricity and natural gas are not available in most parts of the country, and the rural population has been living with a serious shortage of fuel for cooking as well as for other essential needs such as processing of paddy. What is more alarming is the fact that this energy shortage is likely to worsen in the coming decades with increasing population pressure. In such a situation maize stalks and husks could serve as fuel in the countryside. In the long-run, maize can also be used for ethanol production as a substitute for petroleum based fuel.

Maize can be grown all year round in Bangladesh and can therefore be fitted in the gap between the main cropping seasons without affecting the major crops. It can be harvested as fodder within 50 days of planting, as green cobs within 60-80 days and as grain within 100-130 days of planting. This flexibility allows the crop to fit easily into the cropping pattern. Another advantage of maize is its capacity to germinate under varying conditions. Maize can be dibbled in the flood prone areas as soon as flood water recedes without waiting for the soil to dry, at a time when no other crop would grow. Maize can be grown in these areas under no tillage and with minimum inputs. This type of land totals around 2 million ha. In the winter season in some cases, maize may compete with wheat, pulses, oil seeds and other rabi crops. Pulses, oil seeds, onion, garlic and potatoes can be intercropped with maize. Careful planning can also reduce the competition between maize and wheat since availability of land in the winter is not a problem.

In the summer season (March to June) maize can be grown in the northern Districts without affecting transplanted *amon* rice. However, during this period maize will compete with local rainfed and upland *Aus* rice, a less productive crop of the region. If maize can be substituted for local *Aus* rice in the Northern Districts, grain production will be much higher. The only other crops which could compete with maize at that time are summer pulses which can be intercropped with maize. About 1.5 million hectares of land is under cultivation of local *Aus* rice in the northern districts. These land may be brought under maize cultivation without any problems and in other parts of the country the hilly areas are also available for maize culture. The country is estimated to have many hectares of waste land mostly in the forest districts. This area could also be brought under maize cultivation without much difficulty, as state controlled maize farms or by distributing the land to small co-operatives.

Availability of suitable land in future for maize cultivation in Bangladesh is shown below:

Type of land in Bangladesh	**Area available for Maize Production in Bangladesh (million hectares)**	
	Minimum ha.	**Maximum ha.**
Flood-prone districts (October to January)	0.5	2.0
Cultivable fallow land in the winter	0.7	1.0
Substitute a half of the local *Aus* rice area in northern Bangladesh	0.5	1.0
Waste forest land	0.5	1.0
Others	0.1	0.5
Total	2.3	5.5

Cropping patterns in Bangladesh including for Maize:

Maize can be grown in Bangladesh with other crops in several combinations as discussed above. Existing patterns and possible associations of maize with other crops in Bangladesh are shown below:

Land type where maize can be grown	**Existing pattern**	**Maize in combination with an alternative pattern**
Flood-prone district or Medium Low land	Fallow+fallow+*Boro* HYV B. *Amon*+*Boro*	Maize (green cob)+HYV Boro ~~*Boro*~~+Maize+B. *Amon*+*Boro*
Winter fallow (Medium high land)	B. *Aus*+T. Amon+Rabi Crop B. *Aus*+T. Amon + Wheat	Maize+T.*amon*+Potato/Rabi Crops S. Vegetable+T.*amon*+Maize Maize+T.*amon*+wheat
Winter fallow (medium lowland) Substitute of Local *Aus* land	Jute+T.*amon*(HYV) *Boro*/Wheat B. *Aus*+T.*amon*+pulse/oil seeds	Maize+T.*Amon*+Rabi Crops Mungbean+T.*Amon*+Maize Maize+T.*Amon*+Rabi Crops
Waste or forest land		Maize (winter) Maize (summer) Wheat-Maize Potato-Maize
Hilly Districts	*Aus*+sesame+fallow	Maize+summerice/sesame Maize+vegetables winter vegetables+Maize

Seed bed preparation:

A seed bed is suitable for efficient crop production must be sufficiently and finely cultivated to allow even seed germination. If may need to be protected from erosion hazard, since finely divided soil washes easily in heavy rain.

Land for maize is usually plowed deep (15-20cm.) to turn under crop residues, weed growth and manures. Ploughing more then 18cm deep is regarded as impractical, and does not carry any benefit (Nebraska research). Final land preparation of seed bed for maize planting following ploughing is by discing and harrowing. The soil of the seedbed should be fine and loose and deep enough to provide a good environment for seed germination.

Usually land preparation starts when a *Zoa* condition of the soil exists (soil moisture at field capacity is *Zoa* condition) 10-15 days before planting. It is designed to destroy all annual or perennial weeds.

Minimum tillage is desirable provided the weeds are properly controlled and seed is able to be placed in the soil under conditions suitable for germination.

In Bangladesh maize is grown in two season, Rabi (winter) and Kharif I (summer). In winter there is little rainfall, while in summer there is a large rainfall. In the Rabi season seedbed preparation is usually on the flat and seed are sown in furrows. Latter the furrows are turned into a ridge to provide easy irrigation. But in Kharif I, because of heavy rain fall the seed bed must be high and well drained so that no water logging occurs.

-Time of planting: In winter, Nov-Dec is best for sowing. In Kharif I April is optimum.

-Rate of planting: In Bangladesh 75 cm x 25 cm. single plant/hill, which provides 50000-55000 plants per/ha. In Indiana in USA, plantings are 20cm. apart in 75cm. rows, which gives 66,000 plants/ha., and the final stand is about 85% of the seed density planted. In western Nebraska, a dry area, 45,000 plants/ha. are required for satisfactory yield under irrigation with good fertilizer management. The seed rate per ha. in Bangladesh is 20-22kg for grain, and 70-90 kg. for fodder. Seed should be planted deep enough to place the

seed in contact with warm moist soil with sufficient cover for protection against birds, rodents and surface drying. The planting depth usually 5 cm to 7.5 cm.

Fertilizer management: In order to maintain good yield in maize, it should be grown in rotation with legumes and green manures to improve and maintain soil health. In Bangladesh conditions, maize is grown in the pattern of maize/green manure or legume crop/transplanted rice. Heavy application of nitrogenous fertilizer before or at the time of planting prior to the monsoon may lead to heavy losses by leaching. First top dressing is at sowing and the 2nd top dressing at knee height, with a possible third at tassel emergence.

Potassium, zinc and sulphur should be applied at the time of final land preparation if these are required. In Bangladesh recommended rates are 80-120 kg. nitrogen, 60 kg P205 and 30-40 kg K2O/ha, 5 kg Zinc and 20 kg sulphur/ha and 5-7 tons/ha of cowdung.

Irrigation: To get a good crop, irrigation should be given as and when required. Irrigation is important at 25-30 days after planting, at flowering and grain filling. Moisture stress during these periods, and especially at flowering, may lead to a reduction in yield of up to 70 percent on the other hand, the early growth period of the crop cannot withstand excess moisture conditions. Adequate drainage facilities should be ensured at planting. Avoid application of excess water in any stage of growth.

In the Bangladesh winter maize generally requires 2-3 irrigations but on light soil the irrigations maybe increased to 4-5. Summer crops do not require any irrigation but sometimes before planting preplanting irrigation is required. Summer maize faces the problem of water logging and heavy wind, which may lead to complete crop lodging.

Weed Control: After sowing of maize the land should be free from weeds for up to 40 days. The weeding operation is mostly by hand equipment. Herbicide application is not popular in Bangladesh as there is abundant cheap man power available. Farmers do not

generally apply herbicide, though experiences from USA suggest that chemical weed control maybe applicable to our Bangladesh condition. The herbicide 2, 4-D may be applied post emergence against annual grass and broad leaved weeds in maize. Post emergence sprays of 2, 4-D are applied when maize plants are 15-25cm high. The usual rate of application per ha is 0.28 kg for ester salt formulation or 0.56 kg for amine formulation. To be effective, sprays must be over the top of the weeds plants. Care must be taken to protect maize plants from some herbicide, and here preemergence herbicide application is better then the post-emergence herbicide application.

Insect pests of maize: In Bangladesh insect attack in maize is not a serious problem. The insects found in corn are:

1. Cut worm: The larvae of cut worm generally cuts the seedling at ground level mainly in winter, resulting in stand loss. The cut worm larvae vary in color from light-glassy to darkish black or brown. The moths also vary in color and are usually gray or brown. Common cut worms are nocturnal feeders. They are found in or nearby the surface of the soil near the cut off plant. Cut worm moths lays eggs which hatch in grasses.

For cultural control: Plough the field after harvesting to expose hibernating pupae to the sun. For chemical control apply 10% sevin dust at 10 kg/ha in the form of ring around the plant and mix into the soil.

2. Wire worm: These damage corn plant at the seeding stage. The insects are small, shining, yellowish or brownish of about 2-3cm long. The adult beetles are brown or black. The larvae generally feed on the seed or the root of the young plant. For cultural control, apply irrigation to the infested cornfield. For chemical control, apply 2.5-3 kg chlordane per ha.

Stem borers: The striped and pink stem borer causes damage to maize plants. The larvae feed on leaf sheaths then eat their way to cut stems causing dead hearts. The striped stem borer has longitudinal brown stripes on the dorsum of the body. The young larvae are

greenish yellow with a black head, larvae are pale yellowish brown and measure about 2.5 cm long, pupae are 1.2 to 1.5 cm. long, slender and light brown in color. The moths are light grayish brown in color of medium size with a pair of beak-like projecting antennae in front of the head. Egg masses usually are laid under the leaves. Eggs are small, oval and creamy-white when freshly laid, and turn black before hatching. Control measures include removal of all grasses and use of chemical: Diazinon 60 EC. in 3 sprays at 15 day intervals.

Leaf aphids: These suck the sap from leaves and injured leaves turn yellowish gray. Pollen shedding is greatly reduced if the tassels are infested. They are small-bodied insects, greenish blue in colours, usually found in colonies on the top leaves, whorl and tassels. The body is pear shaped with a pair of honey tubes. On the abdomen black sooty mould develops in honey dew secreted by the aphids. Control: In early stages when aphids are noticed in colonies on few plant these can be removed, or 0.5% malathion (1cc in 1 liter water) may be sprayed at infestation.

Leaf weevils: These feed on leaf margins puncturing a number of closely arranged irregular holes. The weevils are small in size. The body is ash color with a few black dots. Eggs are creamy white, oval, and layed in soils. Larvae are creamy white and leg-less. Control: The eggs and larvae are found in the soil. Cultural operations and ploughing the soil during the off season reduce the incidence of the pest. For chemical control, use 10% sevin dust at 10kg/ha.

Leaf hoppers: These are small and gray colored. The body is wedge shaped. The nymphs are pale yellow and found in colonies. They suck sap from open tender leaves. Yellowing of the leaves is one result, and a sugary exudation and black sooty mould develops. The plant gradually fades and dries up in affected parts. Chemical control: Apply malathion 60 EC (1 cc. in 1 liter water) and spray on the infested plants.

Leaf roller: The larvae feed on the leaf epidermis and cause longitudinal patches and burned leaf tips. The larvae are yellowish green in colour with a black dot. The adults are delicate moths, yellowish brown with shining wavy markings on wings. For control, same as for leaf hoppers.

Stored grain pest:

1. Rice weevil: (Sitophilus oryzea) is the most destructive stored grain pest in corn in Bangladesh. It is a brown beetle about 2-3 mm long. It is further characterized by four light reddish or yellowish spots. The larvae which feed on the grain are white leg-less grubs. Control practices includes storage of corn in weather-tight rodent proof bins thoroughly cleaned before use. Phostoxin fumigant may be used to control the pest in storage.

Diseases of maize:

Maize is affected by as many as 50-60 different diseases. In Bangladesh maize is a new crop, so there is a little yield reduction due to diseases. The diseases are as follows:

1. Seed rot and seedling blight: The organisms that cause seed rot and seedling blight are carried by the seed or in the soil and often are serious when seed is planted in cold wet soil or when cold wet weather prevails after planting. The seed may be attacked before or during germination and seedlings attacked soon thereafter. The seed may rot and seedlings may die before emergence. The shoot and root of the seedlings that do emerge in warm soil are usually stunted or partly decayed. Seed treatment by fungicide is the most effective control. Arasan is effective in seedling blight but not effective in leaf, stalk and ear blight.

2. Rust in corn: The affected leaves develop on the upper and lower surfaces pustules which are circular or elongate in shape. The pustules rupture the epidermis and turn the leaves brownish in colour.

3. *Corn smut:* Caused by the fungus *Ustiligo maydis,* smut gall may be found in leaves, stems and ears. Damage depends upon the size of the galls. Dry weather, late planting and high nitrogen fertilizer all tend to increase smut in corn. Smut resistant hybrids are the most effective means of control. Crop rotation and destruction of galls may reduce this disease.

Harvest, drying of the grain and storage.

Corn is harvested for grain, green cob, silage and occasionally as fodder. Ear corn at maturity contains approximately 38 percent moisture while the grain contains about 24 percent moisture on average at harvest. Such most grain is unsafe for storage until the kernel moisture content has declined to 12-14 percent or unless the crop is artificially dried. The green cob is harvested at hard dough stage and used as roasted cobs for sale near by big cities.

Silage: Corn for silage should be harvested when about one fourth of the kernels have begun to dent.

Drying: Corn seldom dries sufficiently on the standing stalk and often not when shocked because the husks cover the ear and the cobs are wetter then the grain. Grain shelled in the wet season requires special drying.

Natural air drying: Maize grain can be air dried before shelling by placing the cob on dry ground in the sun. When the moisture content of the grain has declined to 12-14 percent then the grain is ready for storage.

Artificial drying:

a. *Drying with fored unheated air:* Passing of forced unheated but relatively dry air through the grain may reduce the moisture content of the grains. When the moisture content of the grain reaches 14 percent then it is ready for storage.

b. *Drying with heated air:* Drying grain with heated air is costly. Artificial drying to 12-14% moisture should be done with an air temperature of 60-80°C.

Storage: Since prehistoric times, grains has been stored to save seeds and to provide food between harvests. The time of storing may be from six months to a year or more. In under developed countries grains are stored in buildings, underground pits, polythene bags gunny bags, bamboo or wooden baskets and steel drums, etc. Again 14 percent moisture content of the grain is the maximum allowable for safe storage.

Spoilage of grain in storage: Stored grain suffers damage when its moisture content and temperature are sufficiently high enough to permit organisms (insects included) to thrive. Grain-infesting insects are usually ineffective when the temperature and moisture content of the grain when totaled are less than 70. The dry grain that insects consume is converted into growth energy, and respiration releases heat and produces CO_2 and water by breaking down carbohydrate, protein and fat. The released water raises the moisture content of the grain, leading to spoilage by heating and molding in addition to direct damage by the insect. Fungi such as *Aspergillus*, penicillin, *alternaria*, *Cladisporium Helminthosporium* and *Fusarium* are able to grow and multiply when moisture content of the grain is as low as 13.5-15 percent and other species of fungi grow at 16-23 percent moisture. Most of the aerobic bacteria do not multiply unless the moisture content as high as 20 percent.

Aeration of grain in storage: The cooling of grain by aeration is an established practice. Outside cold air drawn through the grain prevents moisture migration and reduces mold and insect activity. A one horse power exhaust fan can aerate 500 tons less of shelled corn in a bin of 2.5m deep.

There is no good specialized storage system in Bangladesh as of now. Maize grain is stored in the same structure as where rice is stored. At the farm level, after harvest farmers store the grain in polythene lined gunny bags for 2-3 months. At harvesting time

the price of maize is low, so when the price has increased then they sell the grain, usually to poultry farmers and feed industries.

Marketing of Maize

The marketing system for corn in is not organized in Bangladesh, so it is very difficult to determine the true picture of demand. The annual demand for green cobs is about 800 tons of grain equivalent, 200 tons as popcorn, 30,000-40,000 tons as poultry feed, 24,000-30,000 tons as starch and considerable possibilities for using maize as human food and for exports.

During the last 5 years many poultry farms have been set up, and poultry feed industries are being established to cope with the demand. In 1996 maize area was 20,000 ha and this year it may increase to 25,000 ha as there is a demand, and profit compares to that of other cereal crops.

Economics of Maize Production

Maize can be a very profitable crop in Bangladesh.

Approximate cost and return of rice, wheat and Maize in Bangladesh

Crop	Cost of Production/ha. TK	Yields and gross Return/ha. TK	Profit/ha. TK
Wheat	8500	2 tons (14000Tk/ton)	5,500
Broad cast *Aus* rice	6000	1.4 tons TK.7000 (TK 5/kg)	1,000
T. *Aus* (HYV) rice	7,600	2.5 ton.=TK 10,500 (TK 5/kg)	3,100
Boro (Local) rice	8500	2.0 tons= 10.000 (TK. 5/kg)	2,500
Boro (HYV) rice	15000	4.5 ton.=22.500 5 (TK/kg)	7,500
T. *Amon* (HYV) rice	11,000	4.4 tons=TK 22000 5 (TK/kg)	11,000
Maize (hybrid)	7,400	6.00 ton=36,000 (TK/kg)	28,600

Seed: Bangladesh has no organized seed production and distribution system for maize. Bangladesh Agric. Development Corporation (BADC) is responsible for distribution of seeds. At present they are distributing open pollinated varieties of maize seed. Farmer are not interested in growing open-pollinated varieties, so there is a crisis of hybrid seed

supply. Some of agents of international seed companies are importing hybrid seeds and selling at $2.5 US per kg which is exorbitant. If the national research organization and private seed companies were more able to produce hybrid seed in Bangladesh then the cost would fall and the farmer will be benefited.

Extension: A strong maize production technology transfer campaign needs to be organized to boost maize production and achieve the target set up by the national government.

Successful maize production campaigns should have a positive training and motivation impact. The ability to provide farmers with the means to radically improve maize productivity is a powerful booster for the extension service. Successful implementation of visible demonstration plots on maize technology is the common ground between the extension officer, researcher and farmers, and their relationship is strengthening. Concerned officials feel their work is significant to the farmers, and because of this the farmers gain respect for the extension worker. As such the motivation program will create enthusiasm in the mind of the farmer to accept the technology of maize production. The extension officer and the farmer will then begin to function as true change agents for rural development. Maize production campaigns can accelerate the adoption of technology by the farmer who uses low yielding production technology.

Another major objective of Maize Production campaign is to demonstrate research advances to policy makers. Successful Maize Production campaigns involve many farmers and influential people together to understand the philosophy of the campaigns and the projected impacts.

The main components of maize Production campaigns are:

1.- Demonstration: Presently the Extension Dept. sets up many small demonstration plots (50-100 sqm.), using this data to extrapolate small plot yield to the yield per hectare. The

problem is that the farmer cannot visualize this extrapolation, so effective demonstrations should be at least quarter to half ha in size.

Farmer managed demonstration plots are at the heart of an effective maize technology transfer campaign. Once the superiority of maize technology is verified in demonstration plots by the farmers themselves then the technology will be disseminated to the farmer very easily. The participation of farmers in this field demonstration plot is essential. S. A. Knapp, the founder of U. S. extension service stated the rationale almost a century ago, "What a farmer hears, he rarely believes, what he sees in some one else's field, he often doubts. What he does himself he cannot deny". So quarter to half hectare farmer-managed demonstration plots should ensure the participation of neighbor farmers so that demonstration plots are used as a farmer training venue, and so that farmers can learn and see the technology demonstrated. The extension official will also invite the policy makers, and other influential people to well managed demonstration plot to educate, inform and to catalyse change. In a well managed demonstration plot, both the farmers and extension officials will be trained practically.

Now in Bangladesh the Maize Promotion activity is carried only by the TCTT project and the Maize expansion project under the Extension Department. Their main work is block demonstrations. They are conducting 30-40 block demonstrations throughout the country. At least 10-15 block demonstrations will be conducted in each maize growing area.

To promote the maize production campaign/successfully the following steps should be taken by the national government.

1. A well organized agriculture extension program to be established for rapid expansion of in maize.
2. More funds to be allocated for research, extension, marketing and procurement of maize.
3. A well organized Maize Research Center to be established.

4. A good marketing system to be established, with a support price scheme.
5. Food department should take proper steps for procurement of maize.
6. A Production package technology should be developed by the appropriate maize expert.
7. 5-10 (5 ha) blocks in each maize growing area to be organized, properly involving participation of the farmer.
8. A strong maize extension cell to be organized in the extension department H. Q.
9. A strong action program to be taken to supply inputs to the door step of the farmer.
10. A well organized credit system to be organized for credit specially to maize farmers.
11. Established industries based on maize.

Research

Maize Research in Bangladesh is at an initial stage. Systematic research is needed on the various aspects of maize production for strengthening maize research in the country. The following points may be considered:

Improvement of genetic resources

- A well organized breeding program having adequate technical staff is needed at BARI.
- Emphasis needs to be given to the collection, evaluation and improvement of exotic germplasm as well as already adapted strains.
- Development of inbreds for the production of hybrids.
- Introduction and development of QPM.

Agronomic Research: May be concentrated on the following aspects: Variety evaluation should be done on the basis of yield per day instead of yield per crop cycle. Variety evaluation can also be done in terms of effective green cob production, kilogram fodder produced per day or straw production per unit time. In variety evaluation, root and stalk lodging tolerance, degree of insects and disease infestation, plant and ear high, synchronization between pollen shed and silking should be considered.

Technology for rainfed farming.

Over 90% of maize in grown under rainfed conditions in Bangladesh. Therefore, proper technology is needed to be developed for better crop husbandry under these condition. Besides these, genotypes that can withstand water stress or excessive water conditions should be identified.

Bangladesh National Government should take up a 5 year Maize Production Program immediately:

The Potential land availability for maize Production in 2.3-5.5 million ha.

1997	the achieved maize areas	20,000 ha.
1998	the area of maize is increased to	25,000 ha.
1999	the target for maize production is	50,000 ha.
2000	the target for maize production	80,000 ha.
2001	the target for maize production	100,000 ha.
2002	the target for maize production	120,000 ha.
2003	the target for maize production	150,000 ha.

To achieved these above target, the inputs, the training of farmers and procurement of the maize must be well organized and easily available to the farmer.

References:

1. ISLAM. T. M. TAJAL AND KAUL A. K., 1986. "Prospects of maize in Bangladesh". FAO/UNDP. Dhaka, Bangladesh.
2. WARREN, H. LEONARD AND JOHN H. MARTIN, 1963. "Cereal Crops". The Macmillan Company, London.
3. SAMUEL R. ALDRICH, WALTER OSCOTT AND EARL R. LENG. "Modern Corn Production" 22nd edition.
4. JOGINDAR SINGH. "Breeding Production and Protection Method of Maize in India. Indian Agril. Research Institute. New Delhi. 1980.
5. CHRISTOPHER R. DOWSWELL, R. L. PALIWAL, AND RONALD P. CANTRELL. "Maize in the Third World".
6. B.B.S. 1995. Government of Bangladesh.