Hybrid Rice: The Technology to lead Rice Farming into the 21st Century

by Dr. Indrajit Roy

WHENEVER we talk of the hybrids, the crop that invariably catches our imagination is maize. Indeed, hybrids did not only raise to unprecedented levels the yield potential of maize, but also laid the basis for rapid transition of agriculture in the United States, where maize hybrids were first developed and introduced. Between the 1930s and 1980, maize yields in the US more than quadrupled — perhaps hardly there is any other crop where records of yield improvement can match this record growth rate of productivity. Later hybrids were successfully developed and introduced in other crops such as sorghum, sunflower, cotton, pearl millet, etc. The common characteristics of these crops are that they are cross-pollinating, that is, in order to get fertilized and subsequently set seeds the female flower requires pollen (equivalent to sperm in animals) from another plant. This phenomenon makes it easier to produce a large number of hybrid seeds for commercial use without too much effort. This largely explains why hybrid technology has been so successful in cross-pollinating plants. But we hear a lot about modern varieties of rice and wheat, two important self pollinating food cereals that carried the Green Revolution through much of the Tropical Asia. And they are known to have been developed through making a lot of hybrids involving a large number of varieties, lines, and traditional land races.

Isn't, therefore, something here that may make one confused ? Yes, there is, this is in order bring out an important differences. When we talk of a hybrid crop, let's take hybrid maize, we mean a commercial crop raised from the first generation seeds (F1) obtained from crossing two varieties that are genetically different. The planting material F1 seed, thus needs to be produced every year and in quantities large enough to allow plantings on a commercial scale. The hybrid technology capitalizes on the exploitation of an important genetical phenomenon, heterosis, — an enhanced vigor resulting from cross breeding — which the first generation of a cross traditionally displays. The case for MVs is a bit different. Here breeders do produce F1 seeds but in a very limited amount and not for commercial plantings. The purpose is to raise a population that contains individual plants with a great deal of variability. The breeders then perform the next important task. They select individual plants in this population that have the desirable combination of characteristics. They grow the progeny of those selections, called lines, through at least six generations to stabilize the line and produce true breeding offspring. This process thus produces pure line improved varieties instead of pure hybrids. In other words, for conventionally-bred modern varieties, first generation seed (F1), is the starting point in the long chain of events to obtain a finished product for commercial use. For hybrid varieties, F1 is an end in itself that represents the final product for farm-level exploitation.

It is the responsibility of the policy makers to create conditions where scientists can use their talent and creativity to develop new knowledge and technology, take them to the farmers, and ultimately let them put into use to increase production and support economic growth of the country.

The major constraint that stood for a long time on the way of developing hybrid rice is the absence of a biological mechanism that could facilitate cross-pollination in rice plant. Rice is a typically self pollinating plant with male and female reproductive organs located in the same flower. Conventionally when breeders make hybrids for developing pure-line varieties, they, hand emasculate the female parent separating mechanically the male reproductive part leaving intact the female one which is subsequently fertilized by pollen from another plant. The Chinese scientists under the leadership of Professor Yuan Long-ping at the Hybrid Rice Research Center, Human Province started in 1964 their pioneering work aimed at developing a genetical mechanism that could induce in the female parent male sterility, maintain if from generation to generation and restore it subsequently. This mechanism was designed to make the rice plant behave like a cross-pollinating one and thus make it easier to produce hybrid seeds in amounts that could make hybrid rice production technically feasible and economically attractive. But this research group had to wait till 1970 before they could locate a wild rice plant that had abortive pollen, that is, one that couldn't fertilize the egg (female reproductive cell) in its own flower. It was this source of male sterility that subsequently laid the foundation for successful development of the genetical system that could facilitate hybrid seed production on a commercial scale.

The hybrid rice technology rests on keeping on shelf three types of lines labeled as hybrid rice parental lines. The first one is a male sterile (MS) line because of its inability to produce viable pollen. It is used as a female parent, also called the seed parent, in hybrid rice seed production. The second one is a maintainer line whose job is to maintain the sterility of MS, plants from generation to generation. The third one is the restorer line which when cross with an MS line restores its fertility, leading to setting of seeds.

Evidently the People's Republic of China became the first country of the world to develop hybrid rice and start its commercial planting since 1973. It is now grown through out China in various ecosystems, representing the tropical, sub-tropical, and temperate conditions. In the initial years, the yield gains of hybrid rice were only marginal, yet the success of China in opening a new production frontier to rice farmers in itself was amazing and fascinating. But there were skeptics too. The US Central intelligence Agency, in its evaluation of hybrid rice technology in the late 1970s, rated it as not being a major breakthrough in rice research and estimated the yield gains it offered as too insignificant to become economically attractive.

Taken by Noazesh Ahmed & Nuruddin Ahmed courtesy — Bangladesh

But subsequent developments proved those predictions wrong. in 1990, about 18 million hectares or 54% of total rice area in China were planted to hybrid rice that produced 63% of the total rice in the country. The current yields of hybrid rice in China are 6.6 t/ha in contrast to 4.5 t/ha produced by conventional varieties — a 46.8% growth in productivity. This high productivity of hybrid rice allowed China to reduce its rice growing area from about 35 mha in 1979 to about 33 mha in 1990, while its production rose from 140 to 188 million tons during the same period. The 2 mha of rice land thus saved is now diverted for growing high-value crops. This is an example of how crop cultivation can be diversified in a typically rice-dominated economy. In Bangladesh recently there is much talk about crop diversification. But if we mean business, no one is sure how that goal would be achieved in reality when it is unthinkable to reduce rice area at the current level of productivity.

One factor that many thought would be a limiting one for expansion of hybrid rice is high cost of hybrid seed production. In the early stages, the average yield for hybrid rice seed was only 0.41 t/ha in China, which till 1981 still remained at 0.67 t/ha. At that time the cost of hybrid rice was ten times the cost of non-hybrid rice. But seed productivity rose tremendously in the 1980s and by 1991 the average seed yield rose to 2.25 t/ha that lowered the cost of hybrid seed. There is yet another trade-off: the requirement for hybrid seed as planting material is about half that of the conventional varieties — a factor that eases farmers' access to hybrid seed despite its higher cost. But if the cost of hybrid seed could be brought down within affordable limits, the production technology remains complex that requires specialized skills and a thorough understanding of various practices to minimize costs and maximize returns. The hybrid rice seed production technology is a multi-stage process that involves multiplication of the seeds of MS lines, production of the foundation seeds of the parental lines, and production of the F1 seed proper. In fact, the development of an efficient seed production system was the key to the success of hybrid rice in China.

The success with hybrid rice in China is so impressive that it inspired other nations in the Asia Pacific Region. India, Indonesia, Malaysia, Philippines, Sri Lanka, Thailand, Republic of Korea and Vietnam are the countries that have initiated strong research and development (R & D) programmes on hybrid rice. Most of these programmes are still in the early stage. However, India and Vietnam seemed to be ready to launch commercial production of hybrid rice. FAO, UNDP, and IRRI are providing active and strategic support to these two countries through active involvement and support from the Chinese scientists.

Compared with these countries Bangladesh lags far behind in hybrid rice research let alone its development. The imperatives of Bangladesh to invest in hybrid rice R & D, however, seems to be no less compelling than those countries. This is evident from the demand projections for food cereals made in the Strategic Plan for the National Agricultural Research System to the year 2010 and beyond. The need for incremental production of food cereals are indeed challenging: 5.30 million ton between 1990-2000, 6.17 million ton between 2000-2010, and 6.05 million ton between 2010-2020. The annual growth rate of production required to meet this challenge would be: 2.34-2.77% by 1990-2000, 2.21-2.57 % by 2000-2010, and 1.78-2.12 % by 2010-2020.

For Bangladesh, as elsewhere in the world, the basic difficulty in launching commercial production of hybrid rice is to build an efficient hybrid seed production system. In fact, it has been an excuse for not devoting meaningful efforts to hybrid rice R & D in this country. In other words, we are about to sidestep a technological opportunity to increase substantially the productivity of rice at the current consumption level of inputs. It is, of course, true that the public sector in this country would not stand up to this challenge. BADC , at present can supply an estimated 5% of the seed requirements. Even that is confined to a limited number of self pollinated crops where seed production is technically not a diffieult task. Experiences in other countries show that the private sector is capable of efficiently handling the production of hybrid seeds. Obviously, what is lacking is appropriate initiative to devise methods and institutions that would create conditions for the private sector to invest in hybrid rice seed production. If our immediate neighbours have already achieved commendable success despite the difficulties common to all, there is no reason why this could not be done here when this country has enough of scientific talents to do this job.

In the beginning we have talked much about the Chinese success in hybrid rice. And the secret of this success lies in very strong and effective support that the Chinese government provided from the very beginning to hybrid rice research and development. Scientists' efforts were matched with prudent, dedicated, and farmer-friendly interventions from the government. We, too in Bangladesh, strongly reiterate that gone are those days when major gains were achieved without active support from the policy makers. The era has come to an end when much could be achieved by adding fertilizer and water to the soil. At least, we the scientists are not surprised when we see in newspaper reports that rice yields are stagnating or declining . If we are to survive in this world and feed and clothe our people, it is perhaps time to look around the world and take appropriate lessons. And the lesson is: it is the responsibility of the policy makers to create conditions where scientists can use their talent and creativity to develop new knowledge and technology, take them to the farmers, and ultimately let them put into use to increase production and support economic growth of the country.

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How to Live with Floods

by Razaul Haque & Akhter Hussain

THE pervasive impact of flood on land, people and environment is very distinctive. Each disaster create havoc, causing innumerable losses to life and property, especially affecting the poor. The RDRS working area covering 28 Thanas in 6 districts with a population of about 6 million in the northern region of Bangladesh is most susceptible to flash floods and over-bank floods, mainly for the mighty Brahmaputra, Dharla and Teesta rivers. The short and long term impact of the floods on the poor (about 80% of total population) who are RDRS target people and on development activities of the area is very adverse. Particularly, the Kurigram and Lalmonirhat Districts in the north-east, with a population of more then 2.5 million, of which about 2 million are extremely poor, are worst effected again, the poor living in the Chars and river embankment areas of RDRS working area are particularly vulnerable to flood which most of the time cause severe damage to their immediate environment and make their living inhumanly difficult.

The development aim of RDRS, which assists more then 200,000 households annually, is to achieve sustainable increases in the living standard of the rural poor through development of peoples knowledge and skills to live and prosper within the natural environment, and also to minimise the adverse effect of natural calamities, including flood.

THE FLOOD ACTION PLAN (FAP)

Over the last three decades, a series of plans have been chalked out and efforts have been taken to contain flood and it devastating effects on economy and people's life. The latest in the series is the much orchestrated Flood Action Plan (FAP) initiated after the devastating floods of 1988. The nature and size of FAP suggest that it might have a major bearing on the natural environment of the country and on the population. As such, RDRS like other organisations has been keenly observing the process and development of Flood Action Plan (FAP) activities since inception.

The main objective of FAP were to:

- *safeguard life and livelihoods;
- *minimize potential flood damage;
- *improve agroecological conditions for higher crop production;
- * meet the needs of fisheries, navigation, communications and public health;
- * promote commerce and industry; and
- * create flood-free land for a better living environment.

The original FAP plan document listed 26 activities altogether: 11 main components and another 15 supportive studies. Subsequently, some of these components were sub divided, or developed new off shoots studies. Of the main FAP components, there were 5 major regional studies covering most, but not all, parts of the country.

An evaluation of the progress made it possible to identify some of the issues/aspects that were not taken into consideration appropriately and needs now to be duly addressed. A major shift in policy was for FAP to move away from flood mitigation to flood management. Soon, this too shifted further in integrated water management. The reason for the above stated policy shifts in respect to FAP may be attributed to the reactions manifested by the academics, environmentalists, donor community and above all, by the NGOs on possible impact of FAP interventions on environment and poverty situation.

People have to live with floods. They therefore, must learn how to manage them to avoid the devastation of over-flooding.

APPREHENDED IMPACT OF FAP

Agriculture: The primary objective of the flood control and drainage projects in Bangladesh has been to increase agriculture production by providing protection from high flood and drainage facilities to dispose off excess water and the conversion of wetland to drier lands by replacing deep flooded B-Aman with shallow flooded HYVT Aman. But how far these projects have been successful in fulfilling the above objective has become an issue of controversy. Regional study such as, North West Regional Study found the effects on crop production have generally been positive due to increased use off high yield variety of paddy. On the other hand the South-West Regional Study the expected increase in agriculture productivity is yet to be realised.

Any attempt to purposefully change farming practices by disregarding age old traditions will also have detrimental effects on agricultural production.

Fisheries: Fisheries and fishing people play a central role in the economic and social life of the country. Open capture fisheries in Bangladesh is declining. A number of factors are responsible for this declining phenomenon of which siltation of rivers, *Beels* and *Haurs* caused by flood control, drainage and irrigation projects has been cited as the most important factor. The blocking of rivers and natural channels by cross dams and embankments has caused disruption in the migratory pattern of fish. The preliminary results emerged from regional and supporting studies (FAP 3.1 FAP 6, FAP 12 and FAP 16) showed that substantial losses will invariably occur to flood plain fisheries if the proposed engineering works under FAP projects are implemented.

Bio-diversity: Maintenance and preservation of bio-diversity is essential for sustainable development. Loss of bio-diversity will have a significant impact on the future sustainability of agriculture, fisheries and other production systems. And adverse effect on bio-diversity threatens the natural balance of the country. Flood control measures of gigantic nature may cause adverse effect on the bio-diversity of different species. the Independent Review Mission observed that the use of natural resources in Bangladesh is quite extensive and little is wasted. The Mission is of the opinion that any changes in the water regimes resulting from FAP and similar interventions will have adverse effects on bio-diversity situation.

Human Displacement and Resettlement: Implementation of projects proposed by the FAP will result in large human displacement and subsequent resettlement of them. Such phenomenon creates major human problems. It is revealed from the Jamalpur Priority Projects Study and from some research findings that about 6 million people will be affected and 1.5 million alone living in the *Jamuna* Charlands are likely to be washed away if not otherwise resettled, if projects recommended by FAP studies are implemented in the region. Moreover, river channelisation by FAP embankments will increase the risk of flood damage for downsteam areas and for land and population between embankments.

Socio-Psychological: Implementation of FAP Project will have great socio-psychological impact on the lives of the people living in the proposed project areas. As discussed earlier, a large number of people will lose their lands including homestead due to land acquisition. This implies that they are to settle and work in different environment. These displaced people will have to look for new homes and livelihood in other areas. Such socio-psychological effects on people to be affected by the FAP projects will further aggravate the acute poverty situation.

It may be stated that normal floods are sometimes blessing in disguise as the flood waters from the upper riparian region brings alluvial soils down to the plains which in reality act as natural fertilizer for the following crops. What plays havoc through destruction of crops, properties, livestock and human lives etc. are occasional heavy floods inundating crops lands, homestead etc. Essentially the problem is of drainage congestion, which may be solved by allowing silt-laden floodwater to move cross country without hindrance by physical obstructions.

In RDRS's perception, structural solutions to flood as proposed in the FAP studies are very costly and will lead to large scale human misery. Therefore, in reviewing and final planning of the FAP activities the following points may be considered:

- attention should be focused on flood preparedness at the community level;
- there is a great need for a proper cost benefit analysis;
- FAP to be treated as a category case from environmental view point;
- the effects of earlier schemes should be taken into consideration;
- planning of FAP like initiatives should take international and regional factors into consideration;
- within Bangladesh, planning is needed at local/regional/national level;
- people's participation is a necessary pre-condition regarding FAP;
- local capacity to deal with floods should be incorporated in FAP plans;
- the consequences of displacement of the population should be addressed;
- attention is needed for flood mitigation rather than flood protection;
- NGOs should be involved in FAP related activities.

The broad objective of RDRS approach is to minimise loss of life, damage and disruption suffered by people especially the poor during flood. They try to achieve this end by establishing sustainable disaster-preparedness programmes at the grassroots level with active local participation and involvement of local organisations of the poor.

RDRS believes that flood damage can be minimised when people are educated on longer term means of reducing their vulnerability (mitigation). RDRS has approached the flood problem from a different (more human) perspective. Flood is a time bound, natural phenomenon and people have to live with it. As such, RDRS puts emphasis on a) equipping the people with necessary knowledge and skills to encounter any disaster situation caused by flood, and b) minimize the adverse effects.

RDRS's training and awareness-building activities are generally targeted towards the following groups: poor households living in flood prone areas; emergency volunteers to be nominated by the community; — staff of NGOs operating in the locality; and - members of local government.

The mitigation training and measures include: - cultivation of flood resistant crops; diversification; homestead gardening; change of food habit (promotion of potatoes instead of rice, which can be stored for emergency use); planned livestock rearing, and sale prior to flood; improved storage facilities and food preservation; ground raising and construction of flood resistant house; tree plantation; small scale irrigation; and health education (including clean water and sanitation).

Preparedness training and programmes included the following: — storage of dried food, seed and drinking water; money saving; — construction of flood shelters and raised grounds; —flood proofing housing construction; — early warning system.

An in-depth review of several studies and pilot projects undertaken by FAP so far reveals that basically structural solutions to flood problems have been given utmost importance. The nonstructural people centred options have not received due considerations. The reality in the context of Bangladesh is that people have to live with floods. Emphasis should therefore be given on a comprehensive management of disaster caused by over-flooding with full and active participation of the community people.

The writers are associated with RDRS

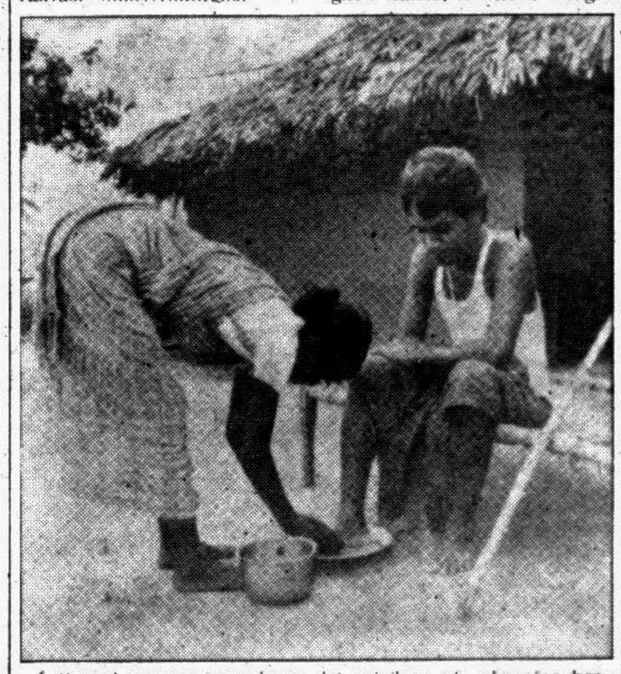
Taking Matters into Their Own Hands

by Raffat Binte Rashid

IT might sound a bit stance to some of us who are not accustomed to this very unusual kind of custom. But basically when a Santal women is refused by her partner, who having had relationship with her, fails to give recognition, she takes matters into her own hands.

This sort of marriage, where the Santal woman forces the man into such bindings though rare in their community is allowed. It is called Nir Bolok Bapla.(The generic Santal word for marriage is bapla.)

Women in the Santal community are no different from us Bengalees or members of other tribes. They maintain the household chores, rear the children, weave clothes, entertain guests but at the same time work shoulder to shoulder with their males in the fields says Teresa Tudu, Training Secretary Bangladesh Adivasi Samity, Takurgao.



A Santal woman may have the privilege of choosing her husband — even if he may not choose her.

"These Santali speaking women have no idea of the world outside their village. "Tudu explains.(Though many of the Santals are bilingual people, they have been able to retain an aboriginal language to the present day.)

"These women are hard working and can shoulder a man's work without hesitation, yet when it comes to decision making they have no say, let alone any suggestions. In simple words men are the bosses," laughs Tudu who completed her Masters from Rajshahi University and is now looking for a job.

Like any other woman of her age and time, she is outspoken, bold and determined, setting an example among other womenfolk in her clan.

"When a Santal girl crosses her university level or even is a graduate she fails to find any suitable match, as no boys are of her calibre or status," Elias Marandi confesses. Marandi and Tudu passed out from the same university.

"Girls who are Santal Christians are coming out of their shells. Still the ratio is five is to one — if five boys are enrolled in school from a village then only one girl will accompany them," he says. Moreover a girl's education expenses are expensive than boys for they need a secure place to reside if schools are far away from home. They need better clothes too etc.

"Our female ancestors never knew what education was for, they were binded by strict social and cultural norms and were happy that way," Tudu relates explaining further that when it comes to work they get equal shares but when it comes to rights they are offered none.

If a father wishes to give his daughter, part of his property only then he includes her in his will otherwise legally she gets nothing. Except maybe her bride-price(paan in Santali.)That too is given to the girl's father, it was a meagre amount of Tk.12 before, is now increased to Tk.40 in some villages. The payment of money is intended as proof of legal possession. A calf is given to the girl's brother in case of *Ghardi jawae bapla*, a marriage arranged by the parents.

Santal women have very few rights. Though their divorced women or widows can remarry these Santal marriages have no registration or written documents. Applying vermilion on a girl's forehead is the main act, this gives a man to claim the lady of his choice as his wife. This he can do forcefully or with everybody's consent.

These women, most of them illiterate, are content the way life goes on for them, weaving clothes, mats, working hard for no recognition. But as time advances so do women, be they Santals or Bengalees. Girls like' Teresa Tudu and others can bring change to their lives and in the process change the entire society for the better.

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