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Rice Development Strategy Towards Food Security: BRRI Perspectives

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Food security is not just growing more food. It means the accessibility of general mass to food for better life. And the food must be balanced, safe and nutritionally enriched. The access to food is possible through growing more or purchasing from the market. Therefore the purchasing power is another component of food security which is dependent on people's income. Food security is a major concern of the government. That is why the National Food Policy (Ministry of Food and Disaster Management, 2006) was made to ensure:

Adequate and stable supply of safe and nutritious food;

Accessibility to food through enhancing people's purchasing power; and

Adequate nutrition for all, especially women and children.

Growth in rice production has been increased tremendously in the country from 11 million ton in 1971 to 35 million ton in 2014. The production during 1996 to 2001 and 2009 to 2014 is quite contrasting compared to the other years. Rice and Rice farming systems play an essential role in reducing food shortage and poverty and help to attain food security. The present policy of the government to integrate science, administration, political will and farmers' toil are really working well towards food security. Per capita availability of food grains (rice and wheat) increased from 444 grams in 1991-92 to 598 grams in 2013-14. The per head rice consumption per day is 416.01gm followed by vegetable 166.08 gm. Though wheat is the next choice as cereal but consumed a modest amount of 26.09 gm by a person per day. The other auxiliary food items are fish and pulse consumed at the rate of only 49.41 and 14.32 gm respectively. The auxiliary items quite low in amount compared to rice. With respect to dietary context, rice provides not only 72% of calorie but also 62% of protein and 17% of fat to most people in the country. That is why rice is the synonym of food in our country and peoples are taking a handsome amount thrice a day.

The above estimation is based on subtracting 12% deduction for seed, feed and waste. The production in agriculture sector is quite satisfactory; still attaining food security is under an apparent anxiety. The reason is huge population burden over decreasing arable land and resources. The increasing climatic adversaries are the added issues too. The rate of population increase was 2.23 million a year since 1950 to till to date whereas rice production was at the rate of 0.03 million metric ton. The rate of increase for Boro, transplanted Aman (T. Aman) and Aus (T. Aus and upland modern Aus) were 0.06, 0.02 and 0.01 million ton, respectively per year indicating a lion share of the total production comes from Boro rice. If the similar trend continues up to 2020, the country might experience a shortage of food by 1.68 million tons. If the trend is not changed, the shortage might be 6.02, 7.80 and 10.50 million tons by the years 2030, 2040, and 2050, respectively. The amount of rice shortage by 2050 is a massive amount of 30% of the present total production. This situation might occur not only due to the shortage of Boro rice but also due the shortage of T. Aman and Aus rice also. However, this estimation is based on the assumption that no new technological advancement has been achieved over the estimating period. But the reality must be different. But a prediction through the economic perspective is good for a guidance to get ready of the relevant scientist toward the proper direction.

Recent issues

Seasonal variability in rice production is an important aspect to consider in rice sufficiency in Bangladesh. Boro rice, largely dependent on underground water, occupies only 41.7% area but contributes about 54.5% in production. Sustainability of underground water may have a direct relation with the sustainability of rice sufficiency in the country at the present knowledge level. There is little scope to expand irrigation. More so some irrigated land has been shifted already to non-rice crop because of severe draw down effect.

The present coverage of irrigated agriculture is around 6.8 million hectare. Out of this

land 82% is assigned for rice cultivation in Boro season. In contrast Aus and Aman rice are mostly rain-fed. The irrigated land under Aus and Aman is only 7% and 5%, respectively. Even these rain-fed crops do not need fulltime irrigation. The supplemental irrigation is enough in most of the cases. Irrigated rice requires 3000-4000 litre of water to produce a Kg of rice. This huge share (70%) of irrigation water is exploited from underground source. Thousands of shallow and deep tube wells are in use for the purpose. The water exploitation through these tube wells in many of the irrigated areas is so intense that the annual recharging in the rainy season is not enough. As a result the water layer is getting deeper and deeper.

Aus is more or less a rain-fed crop. But the yield is low compared to that of Boro. Accordingly, farmers turned towards irrigated Boro rice even with the expense of their traditional upland Aus land. The water holding capacity of the Aus land is low. Therefore, water wastage in this land is quite high. As farmers have to grow more rice, they did not have any alternative options. The coverage of 3.0 million hectares under Aus after the independence has been reduced to 1.0 million now. In contrast Boro coverage once limited to the haor area only, increased from 1.0 million hectare to around 5 million hectare. It means Boro grabbed around 2 million hectares of upland once used for Aus cultivation. This trend has been in progress for more than four decades.

Aman as a season is not much pleasant as the season has to experience flood, flash flood, drought, tidal submergence, water stagnation, salinity etc. Despite these limitations, the area coverage of T. Aman is the highest (5.5 million hectare). But the total production is lower than the Boro crop as per hectare yield is less than Boro. The area of Deep Water rice has reduced from 1 million hectare to 0.5 million hector just because of irrigated Boro rice culture.

Strategic issues

To escape from environmental disaster we have to impose restriction on the use of ground water. For this, one way is to bring back the Aus cultivation to its original position, and the other is to cultivate crops which need less water. Or we have to use surface water. The best way is to develop water efficient rice varieties and crops. But these means are not so easy. Beside this, a sudden turn to Aus ,might have severe impact on total rice production. So we have a lot to think over this.

The reality is – it is hard to bring back all the potential Aus area from the existing Boro culture. So it is better to find an alternative option. BRRI has estimation on trial and error basis to achieve the target without affecting the demand for total production. Let us consider that 20% (0.829 million hectare) Boro land is converted to Aus. Then total Aus hectarage will be 1.85 (including the existing Aus area) million hectare. So some 3.18 million tons of Boro will be reduced from its total production (all these calculations are in terms of clean rice). The average yield of modern rice (clean rice) is 2.02 ton per hectare. To satisfy the gap of Boro, the yield of Aus should be increased to 2.83 ton per hectare. Then total Aus production will be 5.25 million tons. If we could achieve this situation, then we do not have shortage to rice in near future in the country. This is a simple estimation. However, we need some better Aus HYV.

Some varietal developmental issues

Bangladesh Rice Research Institute (BRRI), under National Agricultural Research System (NARS) is mandated to research on development of rice. Rice research focuses on this variability mainly targeting higher yield. Rice ecosystems are mainly facing environmental stresses like cyclone (SIDR, AILA, NARGIS), flood, submergence, drought and fluctuation of high and low temperature. To sustain self sufficiency in rice, production and productivity must be increased. However, some research and development strategies related to the development of appropriate varieties and component technologies in order to satisfy the specific requirements of different rice ecosystems are highlighted below:

Breeding is a continuous process and we always need to develop new varieties which can fit different agro-ecological conditions of the country. There are thrusts and necessities for the development of more varieties both for favourable and unfavourable ecosystems in order to secure food security. However, in case of rice, varieties with the following criteria are required to develop considering specific breeding demand of Bangladesh. The necessary steps taken by BRRI for attaining those goals are also illustrated.

Irrigated rice variety having yield potential as like as BRRI dhan29 but growth duration like BRRI dhan28 or less than that: Efforts have been undertaken to develop a rice variety having growth duration like BRRI dhan28 or less but grain yield potential like BRRI dhan29 through conventional breeding. In parallel yield enhancement QTL(quantitative trait locii)s should be found out through biotechnological approaches in order to develop such varieties. Particularly, land races having yield enhancement QTLs is the process of hybridisation scheme. SPIKE QTL (more spikelet QTL) should be introgressed into the genetic background of BRRI dhan28 and BRRI dhan29. Biotechnologists had some anther culture product with good yield and grain quality having growth duration little less than BRRI than28. They have some encouraging advance lines originated from wide hybridisation and embryo rescue techniques with Oryza rufipogon and Oryza sativa.

Hybrid rice with yield potential more than BRRI dhan29: The potential of hybrid rice technologies for achieving more than 20 percent increase in yield is under study. Increasing the yield potential for the favourable ecosystem where technological progress has reached its plateau should further be explored. Super hybrid rice with earliness and more than12 ton/hectare grain yield potential should be developed. Collaborative programmes with China Hybrid Rice Research Centre and Green Super Rice project of IRRI to develop super high yielding rice is in progress.

Rain-fed lowland rice with yield potential like BR11 but possessing long slender grain: Efforts should be strengthened to develop such variety through conventional breeding. Some advanced breeding lines have been developed with long slender grain, high yield potential having shorter growth duration.

Rain-fed upland/lowland rice with better adaptation as Aus rice: BRRI dhan48 (lowland)

and BRRI dhan65 (upland) are performing well in the field and another upcoming variety Nerica mutant is expected to perform so. The variety with the adaptability as traditional Aus rice and tolerant to high temperature in the reproductive stage is under study. More effort should be strengthened to study the molecular approach.

Rice varieties with resistances against major diseases and insects: Rice varieties having resistance against disease like Bacterial blight, Blast, Sheath blight, Tungro etc. and against some major insects like Brown plant hopper, Gall midge, etc. should be developed through collaborative programmes among different research divisions like Plant Breeding, Biotechnology, Genetic Resources and Seed, Plant pathology and Entomology. For attaining this ambitious goal, coordination among different divisions should be strengthened. Both conventional and marker assisted selection tools are in progress at BRRI for developing such kind of varieties.

Irrigated rice varieties with short duration, cold tolerance and aerobic adaptation: Efforts should be undertaken in collaboration with different donor agencies like KOICA (Korean International Cooperation Agency), IRRI, etc. in order to develop a rice variety having 1-2 weeks shorter growth duration than BRRI dhan28 along with cold tolerance. Rice varieties having aerobic and anaerobic adaptation and Alternate Wetting and Drying (AWD) tolerance should be developed for irrigated environments.

Submergence tolerant varieties with enhanced tolerance and short duration: Introgression of SUB1 QTL into BRRI dhan33, BRRI dhan39 and some other Rain-fed Lowland Rice (T. Aman) varieties have been undertaken at BRRI in collaboration with IRRI, IAPP (Integrated Agricultural Productivity Project) and BAS (Bangladesh Advancement of Science) in order to develop a high yielding submergence tolerant varieties with 110 to 120 days growth duration. Efforts should be undertaken to map second QTL conferring submergence tolerance from Bangladeshi land races. Hopefully, it will be possible to increase the level of tolerance through this research. Some advanced breeding lines have been identified having tolerance against both submergence and water stagnation stresses which are the demand for many farmers affected by these both stresses.

Salt tolerant varieties with 12 dS/m tolerance for whole life cycle along with submergence and water stagnation tolerance: Collaboration should be strengthened with IRRI and other donor agencies like NATP (National Agricultural Technology Project) in order to develop high yielding rice varieties with enhanced salt tolerance, submergence and water stagnation tolerances. The QTL SUB1, conferring submergence tolerance and Saltol, conferring salinity tolerance should be pyramided into the genetic background of different RLR varieties.

High yielding rice with national and premium quality grain type: A separate project under GOB funding is being run at BRRI to develop premium quality rice varieties for both T. Aman and Boro seasons. Advanced breeding lines with high yielding plant type and grain type like national grade aromatic cultivars (e.g. Kalizira) are in the process of development for T. Aman season. For Boro season, efforts should be undertaken to develop high yielding rice varieties with bashmati type grain quality having long slender grain, elongation after cooking quality etc.

Rice varieties with arsenic tolerance and less arsenic uptake efficiency: A collaborative programme with Cornell University, USA under FFP is going on at BRRI to develop such kind of variety. Some potential donors have been identified from both local and exotic sources having arsenic tolerance and are being utilised in the crossing programme. Efforts should be undertaken to find out QTL conferring arsenic tolerance from the donor BRRI dhan47.

Micro-nutrient and vitamin rich rice varieties: More number of micro-nutrient enriched rice varieties with enhanced Zinc, iron and Vitamin A, etc. contents should be developed at BRRI in collaboration with IRRI. Vitamin A rich BRRI dhan29 breeding lines have

already been received from IRRI and are being evaluated following bio-safety guidelines.
Rice varieties with low water and nutrient uptake efficiencies: Collaboration is going to be made with IRRI in order to introgress phosphorous uptake efficient QTL PUP1 gene into the high yielding rice varieties developed by BRRI. The introgressed varieties are supposed to be high yielder due to vigorous root system. Marker Assisted Selection technique will be followed to attain this goal.
For Bangladesh food security largely depends on rice sufficiency. It is good news the country has recently achieved self-sufficiency in rice. The rate of increase of total production of rice is almost in its plateau. Scientists have to increase the rice genetic gain through the latest approaches mentioned above to divert the plateau upward. But there are lots of direct challenges to cope with. These are: less land per head, less water, less labours, less soil fertility, less favourable climatic hazards etc.
Other challenges of indirect nature are:
Strengthening research-extension liaison
Intensification of crop diversification
Building a sound marketing net work
Value addition of farm products
Ensure access food to the vulnerable groups
Elimination of gender disparity
Ensure food safety through food chain
Sustainable increase of rice production for future food security is absolutely dependent on an effective climate smart rice production system and proper planning. In addition, policy support is an important issue to realise the measure for sustainable rice production system.

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