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Articles dealing with the past activities, present status and future guidelines in one or more disciplines of agriculture will get priority for publication in this journal. Original research work, both fundamental and applied, will also receive priority. The articles, in addition to being on research results, should preferably be on policy, management, advancement and frontier issues of research, extension and economic aspects on different disciplines/ subjects related to agriculture. The disciplines/ subjects would encompass all sub-sectors of broad-sense agriculture i.e, crops, fisheries, livestock, forestry, environment, economics etc.

The topics may also entail current and future scenarios for improvement of sustainability of the fragile eco-system, food security, natural resource management, input distribution & management, nutrition, agribusiness, climatic risk management, human resource development and economic implications of rapid globalization obtaining since the recent past. The retrospects and prospects of agricultural improvement vis-à-vis the constraints hindering progress of agricultural development are burning topics needing elaborate analysis and synthesis for the policy markers, teachers, researches, extensonists, service providers, marketing agents, NGOs and private sector entrepreneurs, will also get preference.

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* Ahmed S.S. 1997, Cytogenetics of the jute, Bangladesh Jute Fibre Res.10(2): 107-110.

* Ali, M.S., S.A. Khan and A.R. Chowdhury, 1998. Production of rice in the changing climatic condition of Bangladesh. Bangladesh Agriculture: 1(1): 9-13.

* BARC, 1995. Fibre Crops of Bangladesh, Bangladesh Agric. Res. Council, Dhaka.

* Khan A.A.1958, Production of rice without irrigation. In: M.A Ali, Bangladesh Agric. Res Council, Dhaka. Pp 217-241.

* Rahman, S.1987. Water stress in potato. In: Annual Report, Bangladesh Agric, Res. Institute, Gazipur, Pp. 170-190.

Editor

*** Two hard copies and a soft copy should be submitted.**

Institutional Innovation in Agricultural Research

M.M. Rahman[1]

Abstract

Institutional innovation is becoming increasingly important in order to address the emerging challenges in the agriculture sector. The context, nature and scenario of agriculture are changing fast. The public sector research institutions are no longer the only source of technology and knowledge. Many players in the public and the private sectors are involved in agricultural research. Unfortunately, the role and functions of these players remain fuzzy. No one clearly understands what its functions should be in relation to other actors. Use of this vast resource and knowledge network through institutional innovation has become very important to address the emerging challenges. Public sector institutions alone cannot solve all the problems. Many of these problems will have to be addressed through generation of knowledge in networks of public and private institutions. Some of the important issues relating to institutional innovation have been discussed in this short paper.

1.0 Introduction

1.1 The need for institutional innovation in agricultural research is becoming critical in the context of rapidly changing demands that agricultural research is facing today. Impacts of globalization, deregulation of markets, growing importance of intellectual property rights, impacts of climate change and renewed call to focus on reducing poverty are some of the emerging issues that need to be addressed through agricultural research in order to boost agricultural production from shrinking land resources. The public agricultural research institutes are facing these challenges with lesser resources. The other players recently appeared in the field of agricultural research in the private research organizations are not well organized in terms of facilities and human resources; and they are not clear about their role. It is, therefore, important to focus on the roles and functions that the public and the private institutions can perform in agricultural research.

2.0 Changing context

2.1 The nature of agriculture and its position is changing, as are the demands on agricultural research. On the one hand, markets and users of agricultural research are playing a bigger role and, on the other hand, climate change and environmental issues are becoming a major concern. These changes give have rise to a whole agenda of issues that need to be addressed in terms of

1. Former Regional Director of ISNAR for Asia and Pacific and Former Executive Chairman, BARC

fields of study. There are again many gray areas. This also changes the roles of publicly and privately funded agricultural research. Publicly funded agricultural research needs to place more emphasis on knowledge generation and moving towards generating knowledge in networks. A good example is the recent works on gene mapping/sequencing of jute crop.

2.2 Again, not only the context of agricultural research is changing, but also the thinking about the organization of agricultural research is also changing. In supporting institutional innovation in agricultural research, and providing guidance at times of rapid changes, the authorities should be more conversant with the continuously emerging and changed thinking. Themes that relate to capacity development and institutions, such as social capital, new institutional economics, networks (as opposed to 'brick and mortar' organizations), think tanks and new modes of knowledge production are the key to institutional innovation.

3.0 New scenario

3.1 Research leaders are somewhat overwhelmed by the rapidly changing context of both the agriculture sector and agricultural research. Overwhelmed in terms of the extensiveness of new issues (which seems to result in too broad an agenda), the appearance of new players in the field of agricultural research (confusion on who our 'clients' are and whether and how to involve the private sector), and the complexity of issues that are at play (simple transfers of knowledge or technologies no longer suffice). There is also a need to focus on important distinctions between the developed and developing countries in terms of needs and realities, particularly relating to technical and financial capacity.

3.2 It is important to focus on innovation and the changing roles of the public and private sectors. The changes that have been described imply that agricultural research institutions should move away from conducting R&D only; they need to move towards creating institutional innovation. Innovation is forged in teams, consortia and networks of different players, and is more often than not born out of conflicting ideas. The private sector is becoming a major player in the field of agricultural innovation, but the public sector definitely continues to play an important role too, be it a slightly different one. The role of the government is crucial in creating conditions in which the private sector can play a useful role, and publicly funded agricultural research plays a crucial role in focusing on issues such as environment and targeting the poor. However, the distinction between private and public sector domain of innovation overlaps and this area poses the greatest challenge.

4.0 Emerging Trends in the Agriculture Sector

4.1 Within **the agriculture sector,** three major trends are emerging. First, the users are becoming more central in innovation and technical change. In the past, farmers were considered the "clients" of research and innovation projects. Now they are increasingly becoming major "partners." Second, market and environment concerns are increasingly driving the innovation

process. Adding value rather than improving production is becoming increasingly important to improving incomes and reducing poverty. Managing rather than using the resources is a key to sustainable gains. Third, the development potential of the agriculture sector is increasingly defined in the international arena. Agricultural development in isolation of the international markets is becoming difficult to achieve, and may even turn out to be a dead-end.

4.2 Agricultural research and innovation is also changing rapidly. New fields of science such as information sciences and biotechnology are driving new innovation. Innovations may be generated in networks, where the farmers and the people from different organizations, different disciplines, and different professions meet. Partners team up but do not necessarily agree on shared objectives in the long run. These networks create tensions, but also allow solutions to be achieved with a wider acceptance and a more balanced benefit profile (e.g., the agriculture, environment and health sectors may benefit at the same time). Public research organizations alone do not solve all technological problems faced by the agriculture sector. A large share of the innovations in the agriculture sector originates from other sources. Thus research organizations have to collaborate and share knowledge with other innovation actors. One of their key roles is to catalyze and nurse the development of innovation capacity across the agriculture sector. This is especially true for poor countries, where the capacity to finance an extensive research system is limited and the private sector has not taken off in any significant way. Combining collective wisdom and knowledge of potential actors, with hands-on experience, is the way forward to innovation.

4.3 The role of private sector organizations and non-agricultural research institutions, including universities is growing. As a result, innovation systems are currently looking fuzzier than that of fifteen or twenty years ago and have become highly dependent on communication and information tools. Within these fuzzy systems, the roles for public institutions are increasingly defined in the development of national policies; supporting regulation and environmental management; and providing support to unprivileged producers. The primary functions of public research institutions are also defined in relation to what the private sector can offer. Profit-generating research may be left to the private sector; and the rest remains with the public sector. This, of course, depends on the growth of institutional capacity of the private sector.

4.4 In reality, the distinction between profit-generating and non-profit-generating innovations is sometimes hard to make. What seems to be emerging as an interesting option is the public-private co-innovation approach in which both partners share research and development responsibilities and contribute to costs. Such collaborative partnerships require convergence of interests and flexibility, and governance mechanisms that allow the multiple partners to come together and to agree on the nature of alliance. Accountability is central to managing co-innovation models in order to separate and justify the expenses that different partners share. Well-developed accountability mechanisms may allow the generation of innovation capacity that can be used towards private, public and mixed purposes. Many of the developments in research and innovation systems of developing and developed countries are aimed at facilitating the shared use of national research capacity towards different purposes.

5. Implications for the Development of Research Programs of the National Agricultural Research Institutes (NARIs)

5.1 Innovation networks are, by nature, more complex and diffuse than research systems, and involve a variety of public and private actors. Public sector research organizations are the key actors in agricultural innovation networks; but to make the innovation network work, they will need to develop effective partnerships and linkages with universities, private sector and NGOs. The new focus could be on how to facilitate agricultural innovation, utilizing all the different sources of innovation. Commercial enterprises, NGOs, universities and public sector research organizations are real and definable entities of innovation networks. A focus on only one or group of public or private sector institutions will not necessarily guarantee that the Government's efforts will ultimately have significant impacts on poverty reduction and sustainable resource use. The Government and the donors would need to find ways of working with both traditional and new actors to facilitate agricultural innovation that impacts positively on the poor and contributes to sustainable development.

5.2 The Agricultural Research Council and the Research Institutes would need to emphasize on the generation of knowledge and the understanding of agricultural innovation process in a context where this can be immediately applied. To do so, the program would focus on capacity building of national stakeholders in developing innovation processes and models. This will require a focus on strategy, policy, performance, and governance of multi-actor activities through networks, alliances, partnerships, integrated chains, etc. Selection of projects will need to be done with the aim of improving, developing and testing tools, methodologies and models to facilitate institutional and agricultural innovation processes, especially those that will benefit the poor. And the outcomes of these projects will be used to raise awareness and to catalyze the thinking on agricultural innovation in general.

5.3 A shift in focus implies a shift in client groups, covering ministries, the private sector, NGOs, foundations, knowledge institutes, universities,BARC and NARis all being possible clients depending on the circumstances. The research program will operate principally in partnership and network mode on subject areas to be selected in consultation with the stakeholders, based on their needs and priorities. The public sector research organizations would principally play the role of strategic change agents. The Research Council should be in a position to initiate and lead the process of institutional innovation.

6.0 Conclusion

6.1 The emerging concept of institutional innovation is a major challenge for agricultural research. It not only involves many partners in the public and the private sectors, not necessarily, having similar objectives but also involves responsibility and cost sharing among partners; complex financial and management issues; and external environmental influences that need to be taken into account for national interest. Initially, a forward looking policy decision and assurance of funding by the Government and the donors will be required to support identification, development and initiation of programs in priority areas. However, a start could be made with one or two on-going programs with he support and initiative of BARC and the Ministry of Agriculture.

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Participatory Plant Breeding - It's Context And Its Challenges in Bangladesh[1]

M Gul Hossain [2]

Abstract

Background

In 1982, Rhoades and Booth (1982) argued that involving farmers in the research process increases the chance of success in the generation of appropriate agricultural technology. Since then interest in participatory research involving farmers received an impetus and publications that documented the advantages of farmer involvement in research, extension and development started accumulating.

Not surprisingly, the importance of involving farmers in plant breeding drew attention. Participatory plant breeding (PPB) emerged during the 1980s and 1990s as a means of better understanding and meeting the needs of poor or marginalized farmers. It drew special interest with a workshop on PPB held in July 1995 in Wageningen, The Netherlands.

The initial definition for PPB given in the Wageningen workshop, 'decentralised breeding controlled by plant breeders to various degrees of farmer involvement' (Hardon, 1995), has by now been broadened to include the involvement of seed vendors, industries, consumers and users (Sperling et al, 2001). PPB has in the meantime been the subject of a number of compilations and reviews (de Boef et al, 1993; Okali et al, 1994; Ezaguirre and Iwanga,1996; Sperling et al,1996; UPWARD,1996;CIAT,1997; Veldhuizen et al, 1997; Wicombe, 1999a; 1999b; 2000).

Before we move further, it is necessary to make the distinction between participatory plant breeding (PPB) and participatory variety selection (PVS), though the two approaches often overlap or support each other. PVS is a form of PPB. While PPB tends to involve farmers at all stages of the research process, PVS tends to be limited where farmers play a role in selecting within stabilised breeding materials already developed by formal researchers and feeding back the reactions to those who decide which variety should be promoted (Thro & Spillane, 2000).

1. A paper originally prepared for the International Conference on Plant Breeding and Seed Systems for Food Security, 10-12 March 2009, BARC, Farmgate, Dhaka but could not be presented. It has, however, been updated, particularly with references in participatory plant breeding activities in Bangladesh.
2. Former Director, Technology Transfer and Monitoring Unit, Bangladesh Agriculture Research Council, Dhaka.

The Context

PPB was a reaction to the green revolution crop varieties that required changes in crop field environment to suit the needs of the high yielding varieties.

* The crop varieties developed in the formal sector (institutional breeding) changed the traditional features of the CDR (Complex, Diverse and Risk prone) agriculture of the South and made it even more vulnerable.
* Institutional breeding triggered the socalled `blue-print', industrial agriculture in the South with crop varieties "impressively uni-form and impressively vulnerable".
* The high yielding varieties developed in the formal sector led to elimination of farmers' varieties.
* With elimination of farmers' varieties, thousands of years' of indigenous knowledge is disappearing fast.
* The consequences were not only erosion of agrobiodiversity and indigenous knowledge but also over exploitation of natural resource bases like soil, water and energy resources.
* After the initial increase in production with green revolution technologies developed through institutional breeding, there has been a decline in productivity due to ecological degradation (pollution caused by use of agro-chemicals and monoculture of genetically narrow high yielding crop varieties with accompanying increase in pests and diseases).
* Institutional plant breeding failed to meet the needs and requirements of resource poor farmers, marginalizing these farmers even further, even though the overall agricultural production increased.
* Apparently the most damaging impact of institutional plant breeding, that seemed to have escaped our attention, was: it destroyed the morale of the farmers of the South as innovators and made them subservient to and solely dependent on institutional plant breeding.

Participatory Plant Breeding Activities in Bangladesh

In Bangladesh PPB gathered interest since a National Workshop on Plant Genetic Resources in 1997. A paper entitled

Participatory Plant Breeding - A Way to Empowering Farming Communities in On-farm PGR Conservation and Innovation" was presented at the workshop (Hossain, 1997). The interested research workers in agricultural research institutes of Bangladesh initiated programmes on PPB. Some examples are referred to below.

Rice

* Apparently the first attempt was made by the Genetic Resources and Seed (GRS) Division of the Bangladesh Rice Research Institute (BRRI). They undertook a project on Rice Diversity Evaluation through Participatory Rice Variety Selection in South West Bangladesh in 2001 (Ahmed et al, 2004). It was a PVS programme with 87 germplasm. Of the 87 germplasm evaluated with farmers' participation, five varie-ties, that ranked 1-5, were not always dependent on yield. Farmers preferred characters like higher straw yield, less production cost, and suitability of growing in deep water even if the varieties were not

high grain yielders.

* BRRI also undertook another study in 2003 and 2004 with 48 Aman rice varieties collected from south-west Bangladesh. This was also a participatory variety selection (PVS) but in waterlogged conditions. The highest number of farmers (243) preferred rice grown in deep water condition along with compact grain (227 farmers), longer plant height (211 farmers), insect resistance (95 farmers) and lower disease infestation (87 farmers) compared to high yield (224 farmers). Farmers ranked traditional varieties from 1-5 rather than the modern variety (BR23) that ranked 11.
* BRRI later on undertook PVS trials for stress tolerance (drought, salinity and submer-gence) of rice varieties for poor farmers (Dr. Tamal Lata Aditya, Breeding Division, BRRI, Gazipur - personal communication). In such studies, eleven short duration rice varieties (SDRs) bred by clientoriented breeding in Nepal were introduced in High Barind Tract (HBT) in Bangladesh to identify farmer preferred rice varieties. Participatory variety selection was used to test the varieties by farmers in their fields, using their usual levels of inputs. The rice varieties were evaluated using focus group discussion, preference ranking, household level questionnaires and indepth interviews.

The grain and straw yields of these SDRs from Nepal were similar to, or exceeded, the check varieties that included farmers' customary varieties and the recently recommended varieties from BRRI. The highest yielding SDR variety, Judi 567, out yielded the most productive check variety, Swarna, by 34%. All the SDRs from Nepal were significantly earlier than the check varieties as much as by 3 - 4 weeks than the most widely grown variety Swarna. The farmers preferred varieties that not only gave high returns, but also fitted well with the local cropping patterns.

Wheat

The Wheat Research Centre (WRC) of the Bangladesh Agricultural Research Institute (BARI) has been carrying out PVS for a number of years. Bangladeshi farmers seem to have stuck to older varieties with which they are acquainted and are not showing interest in better new varieties. PVS trials were undertaken to popularise new varieties developed by the Wheat Research Centre. The latest results (2007-2008) showed that the highest preferred variety in one location (Dinajpur) ranked 3rd in yield while the highest yielding ranked 4th by farmers. Farmers of different locations preferred different varieties. The highest overall preferred variety ranked 5th in yield (Pandit et al, 2008).

The study noted that the results were more helpful in disseminating seeds of farmers' preferred varieties. In 2007-2008, the participating farmers saved seeds of their preferred varieties for their own use and also sold out a good quantity to a significantly large number of farmers and thus helped in disseminating seeds.

The study also revealed that some of the varieties produced high yields in both 'poor' as well as 'good environment' while others produced high yields in 'good environment' but low in 'poor environment'. This helped identify variety stability and recommendation for growing varieties based on their yield stability.

Further work on wheat varieties through participatory variety selection (PVS) in collaboration with CIMMYT showed that farmers' preferred UG99 tolerant variety BAW 1064 that gave 10% yield superiority over the widely grown variety Shatabdi, and BAW 1064 was released as BARI Gom 26 in March 2010. Also seed dissemination through PVS was much faster than the official approach of the Bangla-desh Agricultural Development Corporation (BADC).

Hyacinth Bean

A study on participatory selection of Hyacinth Bean was undertaken by Plant Genetic Resources Centre of BARI (Haque et al, 2008). A total of 521 accessions of hyacinth bean (Dolichos lablab) were characterized, using among others, participatory methods. The results suggested that 7 accessions carried high score in Joydebpur location, 4 accessions scored very high in Jessore location and 9 accessions scored very high in Hathazari location. Interestingly, among the varieties scored in different locations, there were no varieties that were common.

These examples and some others suggest that Bangladesh has taken interest in PPB activities which, if supported, can develop further. Incentives to scientists and farmers along with infrastructure / institutional development would be necessary.

Areas in Bangladesh Where PPB has High Potentials

The fragile ecosystems

The major fragile ecosystems of Bangladesh consist of **(i) the saline coastal area** (about three million hectares) in the south, **(ii) the haor area** in the north-east (over one million hectares of low lying perennial water bodies where adjoining areas are used for boro or winter rice cultivation) and **(iii) the hilly areas** of the Chittagong Hill Tracts and the Greater Sylhet district. Crop production practices in these fragile ecosystems are mostly traditional and productivity is low. One of the reasons is the lack of niche-specific varieties. The mainstream research has not been able to devote adequate attention and resources to these ecosystems. These ecosystems require specialised onfarm approaches for technology development because the ecological conditions there are very different from onstation conditions. Participatory crop research including PPB has high potential to increase productivity in these fragile ecosystems.

Minor crops

Of the nearly 60 agricultural com-modities identified for research priority setting (high, medium and low) in Bangladesh (BARC, 1995), there has been little or no research activities in most of the medium and the low priority crops (about 35). These crops generally fall under minor crops that can be best accommodated under participatory research vis-à-vis PPB for their improvement.

It would, therefore, appear that there is enormous scope and need for participatory research vis-à-vis PPB to improve Bangladesh agriculture.

Challenges in PPB

Some of the challenges facing PPB, with reference to Bangladesh context, were noted in an earlier publication (Hossain, 1997). These are summarised below:

* Since breeders are not usually keen to release breeding populations at an early stage, institutional management should provide incentives to breeders working in participatory plant breeding programmes to include a wider range of advanced lines in their selection process. Similarly incentives for use of local landraces, for strengthening farmers' role in undertaking demand driven breeding programmes (Hardon, 1995b) will be necessary.
* Provision for opportunity costs (such as for farmers' land, labour etc.) in participatory plant breeding would also be necessary.
* The farmers or the communities involved need to be given recognition for the contributions they make and be given equitable share of the benefits (in the form of rewards, patent rights/breeder's rights etc.) arising from PPB.
* Farmer's capability in producing Breeder Seed, Foundation and Certified Seed should be encouraged and recognised. Given the opportunity, farmers can play a more effective role in seed multiplication and distribution systems than the formal sector. Farmers' role will need to not only be recognised but also be supported.
* NARS/ARIs will have to enter into cooperative arrangements with farmer / community organisations (Hardon, 1995b).
* Plant breeders from NARS/ARIs, working on PPB, may need orientation to specific farmer/community systems for problem identification, developing breeding objectives, working with farmer or community managed populations, and developing experimental designs in farmers' fields.
* On-farm conservation would warrant recognition, by concerned national and international bodies, as an essential part of the conservation strategy of plant genetic resources.
* The variety release system will have to be modified from the DUS (Distinct, Uniform and Stable) System, as varieties adapted to marginal areas are likely to fail such requirements.
* Training of farmers for understanding and appreciating the assistance from institutional systems, training in basics of selection and seed technology (seed production, processing, storing, handling), including seed distribution systems, will be necessary.

A review of the DFID supported 'Renewable Natural Resources Research Strategy, (RNRRS) (Niel-and, undated) noted the following constraints with regard to PPB:

* Not all circumstances of situations allow rural people to participate effectively in research and development processes (e.g. heterogeneous or highly mobile or disjointed communities).
* The governance context may severely limit the extent to which 'participation' can be translated into meaningful outcome

(rural people may have very little voice in decision making in the exploitation and management of resources).

* Participatory research projects require new ways of working which are often at odds with research priorities pursued by conventional research institutes and funding agencies.
* Often the process of engaging rural communities in the research process is perceived, particularly by researchers and specialists, to compromise the scientific rigour. This may be justifiable in some cases.

This, however, does not negate the importance of participatory research, especially in geographic and commodity areas where the formal sector has been unable to reach.

Conclusion

In conclusion, I wish to reiterate the points I highlighted with regard to PPB in Bangladesh context in an earlier paper (Hossain, 1997). These still seem valid and are highlighted below:

* The technological gap between the North and the South suggest that the South has the potential for "catching up" (Bonte-Friedheim, 1997)
* The CDR agriculture of the South makes it imperative that it finds its own solution to technical and institutional problems in agricultural research and development.
* Farmers' knowledge about their traditional varieties, about their environment and ecology and their skill in growing plants, often in diverse conditions, are precious virtues which plant breeders can benefit from.
* Participatory plant breeding, linking the best of scientists' and farmers' knowledge, can pave the way to maximising both agrobiodiversity and productivity in the South.
* PPB can increase the breeding success not only in diverse, marginal environments but also be effective in favoured environments.
* PPB would help farmers and their communities enhance knowledge and skill in plant breeding in particular, and agriculture in general.
* PPB would make farmers' communities conscious of the importance of genetic resources in general, and their own genetic re-sources in particular for purposes of conserving, improving and establishing ownership rights.
* PPB would help farmers' communities claim and establish ownership of the genetic resources they have and will have nurtured and developed, and thus will help materialise Farmer's Rights by their own rights of contributions and awareness.
* PPB can help instant technology adoption.
* PPB can pave the way to ecofarming through development of location specific crop varieties and developing sustainable farming systems, as against the top down Linear Model of technology 'transplant', normally practised with varieties developed in the formal sector.
* PPB would trigger interests of farmers' communities in gathering information on germplasm locally available, collecting

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germplasm from national, IARCs and global collections based on felt needs.

* PPB would help restore the morale of farmers' communities both as conservers as well as innovators as far as genetic resources are concerned.

Epilogue

"Farmers have been breeders ever since agriculture began. Scientists have been breeders only for the past two hundred years or so (Vellve, 1992) and have relegated farmers to the background at the receiving end of what is being developed in the formal sector. Plant breeding has too wide an implication to be left with scientists only. Participatory plant breeding is a way to empowering local communities, and meeting social, ecological and economic needs and requirements." (Hossain, 1997).

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Agricultural Research And Extension Management:Achievements and Weaknesses [1]

M. Anwarul Quader Shaikh [2]

I. BACKGROUND AND PROLOGUE

Formal Agricultural Research and Extension in the area called Bangladesh had its beginning even a decade before the 20th century. Bengal Department of Agriculture was established in 1905 in the then British Bengal. Systematic research on jute and tea was started by the provincial Government at the turn of the century. Rice Research was started by the department in 1907. A Nucleus Agricultural Research Laboratory (ARL) was established in 1908 to serve the provinces of Bengal and Assam. The Experimental Station, Dhaka Farm, was established at about the same time. Research efforts were focused on rice, jute, cotton, oilseeds, pulses and sugarcane. Improved varieties of rice, sugarcane and jute were ready for extension to farmers by the end of 1939. (Badruddoza, 2001).

The history of research involving crops, livestock, fisheries and forestry from that stage up to the middle of 1990s is a story of chronological improvement entailing establishment of research entities, infrastructure development, their reorganizations and consolidation into a National Agricultural Research System (NARS). The NARS is comprised of the Bangladesh Agricultural Research Council (BARC) as its apex body and twenty agricultural research institutes (Table 1).

According to BARC Act 1996 (GOB, 1996), BARC is a National Institute and a coordinating agency for research on all aspects of agriculture including crops, livestock, fisheries and forestry. But the said Act needs major amendments to strengthen BARC's authority over the ten ARIs for ushering greater efficiency of the NARS.

The transfer of the improved technologies related to crops, vegetables, fruits, soil etc. was previously handled by the Department of Agriculture with limited fund, manpower and facilities till the establishment of the Department of Agricultural Extension (DAE). At present preliminary extension is carried out by the concerned institutes followed by bigger scale actions by the DAE.

1. Paper presented at the Round Table Discussion on "Agricultural Research and Extension Management: Achievements and Weaknesses", organized by the Bangladesh Academy of Agriculture (BAAG), October 2, 2011, BARC, Dhaka.

2. Former Director General, Bangladesh Institute of Nuclear Agriculture and Former FAO/IAEA Crop Variety Development Expert to the Governments of Sri Lanka & Myanmar.

The extension service of DAE has undergone many changes from the British and Pakistan periods till 1970. During the 1970s several mono-crop extension agencies were created. Simultaneously, the Directorate of Agriculture (Research and Education) was given the responsibility of conducting research. The mono-crop extension services were unified during the last part of the 1980s to form the Department of Agricultural Extension (DAE). This organization has tried many forms of extension approaches till the recent times Lately, it has taken up quite a good number of projects as means of extension which is, however, criticized by some experts.

Extension activities of improved technologies and practices with regard to Livestock, Fisheries and Forests, have been the functions of the respective departments e.g. Department of Livestock Services, Department of Fisheries and Department of Forests. Human resources, funds and facilities in these departments have been much smaller than DAE and, hence, their achievements have been smaller too.

Table 1. NARS institutes with their administrative status and headquarters

INSTITUTE	STATUS & MINISTRY	HEADQUARTERS
1. Bangladesh Rice Research Institute (BARI).	Automomous, Ministry of Agriculture.	Gazipur, Dhaka.
2. Bangladesh Jute Research Institute (BJRI)	Automomous, Ministry of Agriculture.	Dhaka.
3. Bangladesh Agricultural Research Institute (BARI)	Automomous, Ministry of Agriculture.	Gazipur, Dhaka.
4. Bangladesh Institute of Nuclear Agriculture (BINA)	Automomous, Ministry of Agriculture.	Mymensingh.
5. Bangladesh Sugarcane Research Institute (BSRI)	Autonomous, Ministry of Agriculture	Ishurdi, Pabna
6. Bangladesh Livestock Research Institute (BLRI)	Autonomous, Ministry of Fisheries & Livestock	Savar, Dhaka.
7. Bangladesh Fisheries Research Institute (BFRI)	Autonomous, Ministry of Fisheries & Livestock	Mymensingh
8. Bangladesh Tea Research Institute (BTRI)	Department, Tea Board, Ministry of Commerce	Sri Mongal, Moulovibazar
9. Bangladesh Forest Research Institute (BFRI)	Department, Ministry of Environment and Forest	Chittagong.
10. Bangladesh Silk Research and Training Institute	Autonomous, Ministry of Jute.	Rajshahi.
11. Soil Resources Development Institute (SRDI)	Govt. Department, Ministry of Agriculture.	Dhaka.
12. Cotton Development Board	Govt. Department Ministry of Agriculture.	Dhaka.

The Livestock Extension Service has also evolved historically from the British and the Pakistan periods. After several changes in its organizational structure, the Department of Livestock Services (DLS) attained its present form in the later part of the 1980s. The present mandate and functions of DLS include all activities encompassed in livestock development and control of livestock diseases. However, the mandate, functions, structure and management system of DLS have not changed much since 1960s.

The Fisheries Extension Services provided by the Department of Fisheries (DOF) have also undergone many changes like DAE and DLS. The DOF underwent a major reshuffling in 1983 when the present structure was developed by raising its manpower from 2008 to 3411. New posts created during the 1990s raised the manpower number to 4123. Of the total manpower, 845 are technical staff spreading from the Headquarters to the Upazila level.

Both DLS and DOF have no extension agents at the village level. The Forest Department does not have Foresters in the Upazila level. These are serious constraints for these extension agencies and amelioration is needed without delay.

The technology transfer activity of the Forest Department (FD) has been described as poor. The present manpower in the FD is too meager for handling the need of the Department itself as well as the public at large. In 2009, number of sanctioned Class-I posts was 293, of which 100 posts were vacant. It is simply impossible to conduct extension work with only one or two professional foresters stationed mostly in the district Headquarters (Akhteruzzaman, 2010).

II. ACHIEVEMENTS

Most of the institutes of the NARS can boast of good quality research and considerable output in spite of various limitations in the policy and management aspects. The number, size and quality of NARS institutes and especially their performance in increasing production in all the sub-sectors of agriculture have been recognized internationally (Shaikh, 2001a).

The country's broad agricultural sector, specially the crop sub-sector has shown phenomenal growth during the last four decades. The most successful achievement, for example, has been made in rice production. Rice production has increased from around 10 million tons 1972 -73 to about 30 million tons in 2010. Wheat production increased from 0.11 m.tons in 1974 to 0.85 m. tons in 2009 (BBS, 2010). Replacement of traditional varieties by modern varieties having high yield potential propelled the phenomenal yield and production (Nasiruddin and Hasan, 2009). Expansion of irrigated area, especially during the Boro season, use of good quality seed commensurate with awareness creation among the farmers were equally responsible for this immense success. Obviously, alongside the BRRI and BINA, contribution of the extension organization like DAE and service organizations like the Bangladesh Agricultural Development Corporation (BADC), Seed Certification Agency (SCA) and Agriculture Information Service (AIS) were no less important. Similarly, the extension organizations like DLS, DOF (Fisheries), DOF (Forest) had considerable contributions in their respective sub sectors.

The single-most evidence of unprecedented achievement in agricultural research, extension and service organizations is the fact that the country became independent in 1972 with a population of 75 million and a deficit of 1.2 million tons of food grains but became near self-sufficient in food grains in 2000. Considerable improvement in the production of other crops, livestock and fisheries was also recorded.

The current contribution of agriculture to the Gross Domestic Product (GDP) is about 23%, reduced from about 50% in the early 1970's. Another 33% of the GDP comes from the agriculture related rural non-farm sector.

III. THE WEAKNESSES

It is indeed a discouraging fact that average agricultural GDP growth rate of 3.1% during 1980-2000 has declined to below 2% during the last few years. This is an alarming challenge in the face of declining land area of 1% per year (Gul Hossain, 2005) and increasing population of 1.6 million/year. Since 75% of the country's population live in the rural areas, accounting for about 85% of the total poor, an improved agricultural sector (crops, vegetables, fruits, livestock, fisheries and forestry) performance contributing to accelerate agricultural production is highly critical to reduction of rural poverty. But the research, extension and service providing systems are weak and ill-prepared to meet the emerging challenges due to inherent administrative and policy constraints (Shaikh, 2007).

Report on the World Bank funded Agricultural Research Management Project (Shaikh, et al, 2001b) delineates the importance of addressing the unfinished agenda like institutional reforms including governance, autonomy and funding mechanisms of the NARS institutes. In addition, reorganization of the organizations and their mandate review alongside the review and strengthening of the extension and service organizations are thoroughly recommended (Alamgir, et al., 2004).

Although crop agriculture is the main livelihood resource for most farmers, yet the rural poor, in most of the cases, depend on other resources like livestock, fisheries and forestry resources in addition. Therefore, a cross-sectoral holistic approach is overdue. This calls for an innovative research and extension management mechanism. An in-depth study is required to develop and consolidate such an innovative approach.

The livestock sub-sector has a great potential for reduction of poverty and ushering sustainable livelihood. But it still inherits the constraints like low productivity, low technical know how of farmers , shortage of fodder and forages, very limited improved breeding practices, shortage of A.I. and health services and very weak institutional support. The fisheries and the forest sub sectors have also been suffering like the livestock sub-sector.

There are myriads of challenges facing all the sub-sectors of agriculture. Some of the most important ones are summarized here.

A. AGRICULTURAL RESEARCH

The strategy of the GOB for agricultural growth in the country is adequately reflected in its Poverty Reduction Strategy Paper (GOB, 2004) and Actionable Policy Brief (APB) (MOA, 2006). The APB emphasizes inter alia (a) need for appropriate legal and regulatory framework for research and extension and (b) introducing institutional reforms, good governance to make both public and private sector more vibrant and transparent.

Major issues of agricultural research needing policy interventions can be classified into three categories, viz (a) Institutional issues (b) Management Issues and (c) Funding Issues. However, the three categories of issues are highly interlinked and hence do overlap on many occasions. Policy intervention in one is expected to result in positive impacts on more than one category.

1. Institutional Policy Issues

(i). Weaknesses in Bangladesh Agricultural Research Council

(a). BARC, with its partial autonomy and more or less a titular headship of the NARS actually has a scattered, diffused and compartmentalized field of operation. According to management formulae, the system is expensive as well as less efficient. However, in spite of the administrative constraints, BARC has performed a large number of commendable work (Shaikh, 2005), including preparation of Strategic and Vision Documents, Long Term HRD Plan, Criteria for Promotion of NARS Scientists, Reviewing and Approving the Master Plans of ARIs, Reviewing the Mandates and Performance of ARIs and Implementation of GO-NGO/Private organization partnership Project (Shaikh, 2001c).

(b). The composition of Governing Body (GB) of BARC, under which its Executive Council (EC) works, consists of preponderance of non-scientists, bureaucratic hierarchy and political stalwarts, which may pose the risk of misinterpretation of issues. GB's authority over the EC (collective wisdom of experts) may be reconsidered as well as reduced and the latter be expanded through inclusion of more scientific personnel, both in-service and retired.

(c). BARC's current organogram is inadequate in view of the global and international perspectives. Its workload has increased tremendously due to continuous development of research needs and associated administrative and functional complexities. BARC's inadequate organogram, dearth of critical number of manpower in the relevant fields (Shaikh, 2007) of research as envisioned in the NAP (MOA, 1999) and the lack of requisite amount of un-interrupted funding have been responsible for its limited performance in the coordination of research of the ARIs. BARC has been able to perform its functions properly only when funds were available from ARP-1, ARP-2, ATTP and ARMP. A renewed functional improvement is visible now due to funding by the World Bank through the National Agricultural Technology Project (NATP), BARC.

(d). The ARIs receive fund from the ministries, have independent Acts and are accountable to their respective ministries and hence are beyond the reach of the BARC except when it can provide some funds for R&D. BARC's relation with ARIs needs re-examination and streamlining to ensure total fulfillment of its objectives and implementation of its mandated functions of coordination. All the ARIs should be made fully autonomous irrespective of their Ministries and their research funds should be given to BARC. Research funds should be given to BARC for disbursement to ARIs on the basis of national priority and research capability of the individual ARIs. The ARIs should be made accountable to the BARC for their research activities and the funds disbursed for research. Recurrent budget funds should be given to the ARIs directly by the Ministries.

(e). There is hardly any coordination and cooperation or cross-cutting research agenda among the ARIs for solving agricultural problems of national importance. Coordination in research suffers due to the lack of a separate Division styled as 'Coordination and Cooperation Division' (CCD) at BARC. Bangladesh agriculture faces new challenges because of changes in global and regional trade regimes, the IPR regimes etc. Instead of a domestic affair, now it is a commercially competitive sector exposed to the global market. Secondly, unprecedented advancement in global research programs and achievements warrant constant correspondence and cooperation with foreign ARIs and international organizations. This Division will be responsible for national research coordination as well as international cooperation.

(f). BARC's mandated function of primary transfer of technologies (GOB, 1996) through the extension agencies can only be furnished properly if its Technology Transfer and Monitoring Unit (TTMU) is upgraded to a Technology Transfer and Monitoring Division (TTMD). Workable interactions between BARC and the public & private extension agencies including NGOs and Private Sector business concerns have not yet been successfully developed for advancing the primary extension responsibility of BARC. Immediate action in this regard is warranted. Some kind of accountability of both ARIs and extension agencies to the proposed TTMD has to be ensured for smooth transfer of technologies.

(g). More than 350 top scientists from the NARS have immigrated to foreign countries due mainly to poor human resource policy and inadequate incentive structure. Out of 1423 scientists employed in the NARS up to June 2009 only 343 i.e. 24% have Ph.D. degree (Siddique, 2009). No organized educational and training program has been implemented for about 8 years i.e. after completion of the ARMP ending in 2000. Recently, a program has been initiated through the NATP of BARC in a limited scale. A thorough capacity needs assessment for higher education and training requirement of the scientists of the NARS is necessary and a massive implementation program with provision for adequate fund is needed for the purpose (Shaikh, 2010).

(ii). Weaknesses in Agricultural Research Institutes (ARIs)

(a). The foremost weakness of agricultural

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research and management in the country is the serious system diversity due to placement of the ten ARIs of NARS under four different Ministries as well as their diversified administrative status (e.g. autonomous and Government departments). This situation is hindering smooth[3], effective[4] and efficient coordination by BARC.

Administrative and governance mechanisms are to be developed by the GOB by making all the NARS institutes fully autonomous for helping a meaningful coordination by BARC.

(b). Institutional management constraints are being faced in recent times because most of the ARIs were established during 1950s to 1980s but the context and demand for scientific knowledge and technology have changed during the last three decades, dramatically in some cases. But the infrastructure, scientific posts and the research systems have neither changed nor transformed (Shaikh, 2009). Careful and in-depth review of the Organograms, Mandates, HRD Programmes and Current and Five-Year Research Programs of the ARIs needs to be conducted to examine and reconsider whether research with the current organizational setting and research orientation can meet the new challenges (Shaikh, 2010). Collective wisdom of a group of experts is expected to improve the research output to a great extent and, therefore, such reviews are to be initiated for bringing both quantitative and qualitative changes in the research system of the total NARS.

B. AGRICULTURAL EXTENSION

(i). The Weaknesses in the Extension System

Extension agencies related to crops, livestock, fisheries and forestry also have many weaknesses. The DAE officers have very limited scope of getting promotion to higher grades due to lack of requisite number of posts. A review and reorganization of the Organogram of DAE is required. Funding stringency is also a problem needing a reassessment. DLS, DOF and DF are much smaller in size and have limited number of staff and allocated fund. Both of these constraints are to be minimized after a thorough review and analysis of facts regarding these extension agencies.

(ii). Weaknesses in Private Sector and NGOs

Private sector is slowly becoming involved in agricultural research and, to a very little extent, in extension. The efforts are, however, highly business-oriented and mostly directed to enhance promotional activities of their specific products like hybrids, seeds, hormones etc. The public sector organizations, specially the BARC, may coordinate the private sector research efforts as well as link those to the public sector to produce sustainable research and extension outputs. The proposed new C.C.D Division of BARC will be able to implement such a public-private-participated programme.

3. An effective research programme develops technologies and identifies policies that will overcome the constraints of production faced by a subsector.
4. An efficient research programme creates the most benefit to producers and consumers from the resources available to the institute (Reference, BARC, 2000. Bangladesh).

IV. REQUIRED POLICY INTERVENTIONS TO REMOVE THE WEAKNESSES ACROSS THE NARS, AGRICULTURAL EXTENSION AND SERVICE AGENCIES.

Recruitment of Scientists

Recruitment of scientists is not always based on merit but on the basis of external influences. The process of appointment, on the face value, seems to be transparent, but in reality, appointments are very often influenced by outside pressure thereby curtailing the very potential of an ARI. Establishment of an independent "Board for Recruitment of Agricultural Scientists" (BRAS) is essential.

Retirement Age of Agricultural Workers

Since the scientists, extensionists and service providers (in BADC, SCA, AIS etc.) are engaged in increasing agricultural production and thereby ensure food for the nation, their retirement age should be raised to at least 65 years. Retirement of these people at 59 years is a terrible wastage of knowledge and experience for the country. ICAR scientists of India retire at 65 years while incumbents in other services retire at 62 years. India's attainment of self sufficiency would not have come through without such bold decisions.

Promotion System

Promotion of NARS scientists to the next higher grades is given mostly on seniority basis, merit is not the number one criteria. Secondly, promotion is given only if a vacant post is available in the next grade. This system should be changed and a capable scientist should be promoted to the next grade irrespective of availability of post. This system should be introduced for all agricultural professionals. In India & Nepal upgradation of posts of scientists is followed. Seniority, output and line of expertise etc are considered.

Service Rules

Separate service rules has to be developed for the NARS scientists. Civil service rules should not be applicable to scientists since these are counter-productive for managing scientific personnel. Introduction of a Unified Service Rule for the whole NARS is also a need for the day.

Research Management Skill Development

Organized efforts/ opportunities for Research Management Skill Development is absent in the NARS. Scientists are suddenly entrusted with the job of Research Management. This practice is counter-productive because the leadership of an important research project is suddenly abundoned by a senior scientist and the project suffers in the one hand, and the administration / research management suffers due to inexperienced Director/ Director General, on the other. A short training system in administration and research management is to be arranged for highly senior scientists of NARS who would be called for assuming the administrative and managerial posts like Director / Director General.

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The Role of Science in Solving Food Problem of Bangladesh [1]

Kazi M. Badruddoza [2]

It is a distinct honour to have been elected as the General President of the Bangladesh Association for the Advancement Science (BAAS). I am grateful to my fellow scientists for this. My long association with them, and the benefits from their research to which I can testify, give me ample reason to respect their professional ingenuity and skill. I, therefore, seek their fullest cooperation in discharging my duties to the cause of Science and Technology.

We have President Ziaur Rahman with us at the opening session. On behalf of the Association and myself, I would like to say that we feel extremely honoured by the presence of the Hon'ble President at this gathering of scientists from all parts of the country and abroad. It is, indeed encouraging to see that, in spite of his multifarious pre-occupations managed time to come to this function and this shows his keen interest in Science. The scientific community will always remember with gratitude his personal effort in establishing the National Council of Science and Technology, and creating a position of Science Adviser.

His understanding of and concern for rural problems have been a source of inspiration and hope for all who believe that the economic progress of Bangladesh is dependent on the prosperity of her rural masses. I am hopeful that, under his dynamic leadership and clear policy direction, a symbiotic interaction, between science and society will grow, accelerating economic development in the country and improving the standard of living of the people.

Scientific research and study in Bangladesh is carried out by six universities, four research councils and as many as sixteen research institutes/centers. Generally speaking, the basic and supporting research is undertaken by the universities and applied research by the research institutes. Despite various constraints, the accomplishments of our scientists have been of very good standard. A few examples of their many useful achievements were given in the presidential address of Science Conference last year. I do not wish to dwell on these, except adding that advances in engineering sciences, physical sciences, applied chemistry, medical sciences and agricultural sciences have been considerable, both in extending frontiers of knowledge and solution of problems. Our scientists deserve significant appreciation for this.

1.Presidential Address at the Science Conference of the Bangladesh Association for the Advancement of Science, 8 January 1978

2. Former Executive Vice Chairman, Bangladesh Agricultural Research Council, Dhaka.
Scientist Emeritus, NARS-B

President, Bangladesh Academy of Agriculture (BAAG).

Science has, by and large, been connected with industrialization and urbanization, and has not given adequate attention to a comprehensive study of rural problems and their solutions. But it is now increasingly realized that improving Productivity of villages can provide millions of people not only with more food, but also with better housing, clothing, health, education and prosperity. Science has a great role to play in this field. The overwhelming majority of our people lives in villages and will continue to do so for years to come. It is clear enough that unless life in a rural community is made fairly good and sustainable, all the problems of poverty cannot be solved. In fact, it will get worse. Therefore, science must give itself a rural bias, with emphasis on the increased production of basic food commodities, the establishment of labor-intensive industry in rural areas compled with the expansion of input supplies and marketing channels into areas where none had existed before. Our land and water resources are vast and varied. The agro-climatic conditions offer scope for cultivation of a wide-range of crops throughout the year. The assets are great, yet how is it that we cannot provide for the basic minimum needs of our population and that we face problems of under-employment and unemployment? How can we solve such problems? The only real way to overcome the problems, and improve standards of living, is to increase productivity through balanced rural-urban growth.

You will understand, I am sure, that the time does not permit to discuss all the many complex problems that limit productivity in various fields and their solutions. I would, therefore, like to give in my address here emphasis on the most pressing problem we are now facing and the role of science to solve it. It is the food problem in the solution of which there is need for integrated efforts of agricultural scientists, physical scientists, biologists, engineers, nutritionists, chemists and many others.

There is a current annual deficit of about 2 million tons of food grain. The total food grain need for the present population of 85 million and the estimated population of 109 million by 1987 is about 13 and 17 million tons, respectively. A production increase of about 39 per cent is required, if the country is to produce its own food grains. This 39 per cent increase will require an average annual growth rate of 4.5 per cent. Can this be achieved?

In view of limited exploitation of modern technological production potential so far, the most rapid increases in crop productivity can immediately result from the application of known technology, for example, improved varieties of crops, balanced fertilizers, optimum water-management and pest control. Effective High priority should be accorded to irrigations and command area development which can play a major role in this regard. An integrated strategy for utilization of ground and surface water, and for harvesting rain water in each ecological and topographic area, will especially help to raise food production. Use of improved crop varieties, proper time of planting, fertilization and irrigation can even double the yield of many crops grown during the rainy season. It is not only possible, I believe, to achieve the

necessary growth rate but also even possible possible to go beyond this, if we can efficiently use our soil and water resources, and make efforts to reach the small fanners who are poor but responsive. If they can be persuaded to modernize their techniques, and if they are serviced with the nee; institutions, they are as effective in their use of fertilizers, pesticides*"and water as the rich farmers, perhaps, even more so.

Our average yields of rice and wheat are of the order of 1.0 (11.13 mds. per acre) and 1.5 (16.70 mds. per acre) tons per hectare, respectively. The position with regard to pulses and oilseeds is even worse. We have only to compare this with the average yield of rice of 5.6 (62.32 mds. per acre) tons per hectare in countries with small holdings like Taiwan and Japan, and the average yield of wheat at 2 (22.26 mds. per acre) tons per hectare in neighboring West Bengal (India) to see the long gap between what seems possible and what we are presently accomplishing.

There are important farm operations, such as, irrigation and pest control as well as timely land preparation, which will need community endeavour as it would be difficult for each small farmer to undertake effectively these tasks all by himself. It would, therefore, be necessary to develop appropriate institutional arrangements to approach the problem in its totality; else it will be difficult to give substantial jumps in productivity which are, otherwise, well within our reach purely on scientific considerations.

As technology of the future, while we make progress to sustain production and make further improvement, will be required to solve many more complicated production problems than now, it will demand collective action. Consideration may have to be given to fix a minimum limit to operational land holdings, below which the holding should not be fragmented whatever be the ownership pattern. The actual size limit will need to be varied according to quality of the land and water resources.

Production emphasis should not be given to food grains like rice or wheat alone. Equal opportunity exists for pulses and oilseeds, tubers, and multitudes of fruits vegetables and non-conventional foods. This will have a sparing effect on cereal grain consumption and also improve nutritional status of our diet.

In many areas of Bangladesh, the farmer on a small holding can be engaged in labour intensive 'gardening' systems of agriculture such as inter-cropping (planting more than one crop in the same field, perhaps, in alternate rows), multiple cropping (planting several crops in succession, up to four a year in some places), and relay planting (sowing a second crop between the rows of an earlier maturing crop) that are highly productive per unit of land. For example, in China, wheat is planted first. At the end of one month when wheat emerges, maize is planted between appropriate rows of wheat. Later, wheat is harvested, while maize continues to grow. Both are short-duration crops and in about 4.50 months time, two crops are harvested and the combined yields are generally about 45% higher than that could be obtained with a single crop of either wheat or maize. There are many crops which will allow this kind of intensive cropping in Bangladesh and increased yield per unit area. In fact, some encouraging results in this respect have already been obtained by our farmers and research institutes.

There are crops which are not now commercially grown in Bangladesh, but which are highly productive. These are maize and sorghum, and these should be introduced for field-scale cultivation where conditions are suitable. Similarly, soyabean has a good prospect as a pulse or oilseed. More research emphasis should be given to the testing and adaptation of potentially suitable crops such as cassava, oil palm and sun-flower.

There is a serious nutritional deficiency in the diet of the people. In many instances, it is not so much due to lack of food in the market as due to lack of purchasing power of the poor urban and rural people. Therefore, the food problem in many areas needs to be stated not just in terms of a certain quantity of food grains alone, but also in terms of certain man-years of jobs, which would provide the source to buy food by everyone. If there is remunerative market to absorb home-grown food, a major difficulty in producing mere food will be considerably minimized. Self-reliant rural industry and more work for rural people will be needed to generate purchasing power. Numerous industries that are labour intensive and vet can be started with small capital investment, can benefit the rural masses, as for examples, weaving, dyeing, handicrafts and manufacture of locks, latches, paints, etc. There is also need for resources and an effective mechanism to purchase agricultural produce and its storage in good condition. Both uneconomic depression in prices and considerable losses in poor home-storage can be prevented this way.

The above descriptions that testify ample opportunity exists to improve production of crops. Clearly, an extended and improved science is only, one of the requirements. Road systems must be extended as much as power grids; marketing systems of credit. Equally important is a broad based educational system with curricula designed to meet country's needs.

We need to give a much greater emphasis to agriculture than it has been accorded in the past. We must balance resource and population through balanced economic, social and intellectual development. An encouraging fact is that in those areas where agriculture has progressed rapidly in the past twenty years (e.g. People's Republic of China, Taiwan, South Korea and Tunisia), birth rates have gone down.

I have spoken so far about some of the approaches and policies needed for increasing the efficiency of adoption of technology to improve productivity. Emphasis on this, does not mean that what is required to be done on the scientific front has been accomplished. On the contrary, food sufficiency requires more than a few wheat or rice varieties that run out in a few years' time and than simple fertilizer or pesticide applications and irrigation. Our production potential is far beyond what has been currently achieved. There are yet unsolved and complicated problems restricting production and many more will crop up with every change, All these will require continued research efforts to solve various

problems. It is not possible to list here all the problem-areas, but I would like to refer to a few obvious ones to cite as examples.

Problems-Areas:

i. There is need for detailed inventory of land, water and other resources, village by village. This will help in planning and taking appropriate steps needed to improve productivity and reach the food and nutritional targets.

ii. Inclement weather is the most detrimental factor in food crop productivity. More refined and accurate weather forecasting would greatly improve the ability of the farmers to decide the management practices that would increase crop yields e.g. by adjustment of planting date to avoid drought or excess water at such critical stages as germination, flowering, harvest etc.

iii. Studies should be made in the development of low-cost methods of recycling wastes for agricultural use and to optimize the impact of these wastes on crop production. Emphasis should also be given to nitrogen fixation by algae and on the possibility of transferring of the nitrogen-fixing property of legumes to non leguminous plants.

iv) It is essential to establish systems of rotational, inter and relay cropping of legumes and non-legume crops that would minimize the need for nitrogen fertilizer and be consistent with yield of crops.

v) More studies are needed on efficient use of fertilizers- their time of application, placement, up-take and control of losses due to leaching during the rainy season.

vi) Research is need to (a) genetically combine drought resistance, salinity tolerance with other desirable traits to stabilize and increase production in marginal areas; (b) improve plant-water-use efficiency by genetic means; and (c) develop management practices to increase water-use 'efficiency.

vii) Increasing the production of domestic animals, poultry and fish by breeding, reduction of infertility, better nutrition and health, needs much closer study. Disease problems of cattle and the utilization of non-conventional sources of feed require more scientific work.

viii) Forestry research including the introduction and plantation of quick yielding fuel and pulp trees and annual strains of bamboo need more intensive attention and support. Research on chemical engineering and industrial aspects of wood should be strengthened.

ix) Use of chemical pesticide, though harmful for mammals and fish, will continue to be used for the control of crop pests. But there is need to apply them with due care and caution. Surveillance and early warning systems need to be developed so as to predict the appearance of the pests and take timely steps to control them with the minimum quantity of pesticides. This will reduce the present extensive use of pesticides.

x) Erosion is a potentially critical problem in the hill-tracts. Such soil is essentially a non-renewable resource. Effective control methods must be developed and related to different crop management practices.

xi) The hill-tracts ecosystem should be studied in an integrated manner for balanced exploitation and conservation of natural resources.

xii) There are many unexplored tropical plants with economic values. We must scrutinize these plant species, many of which are still untested, but may prove very useful as human food. For example, winged bean, a fast growing heavy bearing perennial which has recently been introduced in Bangladesh, has great potential for small-scale farmers. Its seeds have a higher oil and protein content than soyabeans and the plant has the added advantage for protein rich roots and edible foliage. Similarly, our marine wealth has to be adequately tapped.

xiii) Research on dehydration, preservation, sanitation and control of spoilage of food must be stepped up. This will save wastage and also facilitate export of perishable goods.

xiv) Intensive research attention is needed for the exploitation of unconventional sources of food and energy, such as, algae, yeast, mushroom, water-hyacinth, leaf-protein etc. Water-hyacinth might one day provide a new source of energy, if it can be converted in biogas. The recovery of fuel from this aquatic weed, even if on a small scale, has interesting applications, especially in our rural areas.

xv) Research is needed for low-cost housing, communication systems, water supply, energy system, sanitation, medical care (preventive and curative), indigenous system of medicine and family planning to give effective support to rural development programmes.

xvi) Post-harvest losses during handling, storage and delivery constitute a major constraint for food adequacy. Such losses might be as high as 16% of production and often go unnoticed. Improper drying before storage causes heavy losses due to fungus and insect infestation. Studies on the methods of storage already in vogue in the rural areas should be made to improve them so as to suit the local conditions.

xvii) Attention should be given to develop and produce machinery, equipment, implements, tools and appliances suitable for increasing efficiency of farm operations and rural industrialization using, as far as possible, our own resources.

xviii) The vast majority of our population is outside the formal system of education. It is difficult to bring about social transformation and economic development by depriving them of the benefit of education. The non-formal education can be an important approach to improve their knowledge and skills. Studies should be undertaken to develop ways of non-formal education suited to the needs of the country. Formal education should support and contribute to the development of non-formal education. Vocational training in maintenance and operation of various machineries, beekeeping, fish rearing, poultry and many other new innovations must be developed and introduced.

xix) There is one other area of research needed to complement, supplement and in some cases guide the research done by the scientists. This is socio-economic

research that relates to the overall production, processing, marketing and consumption system. It must be given due importance, if we are to maximize the results of research in other areas.

I have just cited few examples of problem areas. There are many more like these. In spite of good accomplishments so far withthe resources available to scientists, in total, we have only scratched the surface when compared to the challenges and opportunities ahead.

Farm Level Studies:

Generalized recommendations about fertilizer rates, pest control and seed varieties developed under ideal conditions of experiment stations without much regard to such important variables as local climatic conditions, soil types and pests, often failed, when tried in farmers' fields. There is need to identify, through continuing trials in farmers' fields. There is need to identify, through continuing trials in farmers' fields, the specific combinations of crop and animal production practices that will provide maximum productivity and profitability. This involves studies on representative farms of each agro-region, and participation of scientists, farmers and extension agents. Participation plays an important role to introduce new technology. This does not mean that local people have necessarily to participate in the process itself. It means that ways have to be devised by which the local people get interested in the whole process of generation of technology and become motivated to contribute as much as possible. To a great extent, it is basically a matter of dynamic inter-change of relevant information between the scientists and the people. Rapid technology transfer, in the past, has been most successful in those cases where visual evidence of benefits was readily apparent. Similarly, pilot demonstration units are needed in different areas for the different industries to make people conscious of the benefits of new innovations.

It must, however, be remembered that the farm-level research is neither a substitute for research that is carried out at the experiment stations to develop components for farming system such as new varieties, fertilizer use guide-lines, methods to control pests, practices to increase water-use efficiency etc., nor a substitute for basic and supporting research done at the research institutes and universities to extend the frontiers of knowledge.

Coordinated Research:

In order to achieve full benefits from limited facilities, multi-disciplinary coordinated team approach in research is helpful. The various research institutes and agencies may participate as partners in such a programme for the attainment of common objectives. This will avoid wasteful duplication of efforts and make full use of scarce resources, and improve speed of research in solving problems.

While I bring out the need for team approach in the solution of problems, I do not wish to underestimate the individual efforts. Not all good scientists adapt to the team approach. Some of the significant achievements have come from individual efforts. Such efforts of talented scientists should also be encouraged.

Some Basic Steps Needed to Strengthen Present Research System:

I would now like to refer to a few basic steps which deserve consideration to strengthen the present research system.

(a) The financial allocation for science and technology is, at present, very inadequate (about 0.3 per cent of GDP) compared to the existing opportunities and challenges. Whereas in the developed countries, extensive research is carried out by private institutes / industries, they play virtually no part at all in Bangladesh. All of it is wholly financed by the government. In a developing country like Bangladesh, a highly productive approach would be to allocate, at least, 2 per cent of GDP for R & D effort.

(b) Science is international in its origin and application. Stronger links, therefore, need to be developed with the international scientific community to provide Bangladeshi scientists with access to the rapidly developing store of scientific knowledge, skills and materials. International meetings to discuss advances in special problem-areas serve an extremely important function in the interchange of new advances in technology. Greater participation of competent technologists and scientists in such international conferences should be encouraged.

(c) There is need for inter-institutional collaboration at the working level. It is felt that the lack of interaction between university academicians and scientists of government and semi-government research institutes is a major functional problem in the field of science. An effective mechanism will be cooperative research programmes as well as interchange of personnel between the scientific establishments, the universities and the industries, even for a short period of time. Scientists working in the research institutes and universities should be encouraged to spend a certain amount of time as consultants to industrial concerns. This will lead to better communication between industry and scientists.

(d)The most valuable resource in the nation is its trained minds, i.e., the scientists and the technologists. The promotion of scientific workers and their appointment to key positions in many institutions are still based on seniority and not on demonstrated merit of scientific work. This reduces efficiency of active young scientists and encourages 'brain-drain'. Improved selection, evaluation and promotion procedures based on merit should be introduced for efficient utilization of our scientists. Personnel policies should be such as to: (i) promote scientists without shifting from their respective fields of specializations by delinking salary and posts, (ii) deglamorise management positions and (iii) encourage them to work in rural areas without forgoing good educational opportunities for their children and other benefits.

(e) The important scientific societies now operating in the country, should start honouring/awarding scientists for outstanding contributions. This will give recognition and incentives to good

scientists and. improve quality of their performance.

(f) Total requirement of man-power at various levels and in different fields should be carefully worked out in accordance with the need for the next ten years. The National Council of Science & Technology has a definite role to play in it.

(g) A comprehensive National Programme of Training (internal and external) should be prepared and correlated with the facilities available with the educational institutions in the country and abroad so that training proceeds in an orderly manner and the requisite man-power becomes available to meet the needs of the country, It cannot, as is now too frequently the case, be left to an in- coordinated collection of fellowship ortraining award, provided largely by" external technical assistance organizations.

(h) The most stultifying element in government and semi-government research institutes is the civil service system of command structure which is completely unsuitable for the requirements of good scientific work and administration. There is need to carefully study the personnel management systems evolved by institutions such as the US Department of Agriculture, the National Science Foundation and the Science Corporations, etc., and introduce radical changes in the organisation of science in Bangladesh. Creation of a command structure suited to the genius of science is an urgent need to put science on healthy lines.

(i) There also exists an immediate need to create a visible focus for Bangladesh Science, by constructing a Science Centre Building in Dacca. A serious deficiency of the infra-structure of science in Bangladesh is the lack of accommodation for various science organizations. Most of these, including the National Council of Science and Technology, the Agricultural Research Council, the Medical Research Council, the Bangladesh Academy of Science, the Bangladesh Association for- the Advancement of Science etc. are located in rented house or on borrowed space in other institutions without any facility for meetings, conferences, libraries, audio-visual aids, etc. Because of their dispersal, interaction among them or with the scientific community is very difficult. A Science Centre Building should be built in Dacca as early as possible to facilitate inter-communication between various groups and individuals. The Science Building should accommodate the National Science Library and other facilities for dissemination of information and transfer of technology. It should also act as the National Headquarters for popularisation and promotion of science through publications, mass-media materials, exhibitions, etc.

In the end, on behalf of the Bangladesh Association for the Advancement of Science (BAAS) and myself, I offer you once again, Sir, our sincere thanks for your kindness in inaugurating the Third Annual Bangladesh Science Conference. We are most grateful for this favour and trust that the connection between you and BAAS will continue and grow stronger with time.

Ladies and gentlemen, I tender an apology for this lengthy address, and trust that your deliberations in the Conference will be fruitful.

Ownership status of private woodlot owners with particular reference to Jessore District

Md. Saifur Rahman[1] and Md. Saidur Rahman [2]

Abstract

Private woodlot plantation is practiced frequently now-a-days in Bangladesh. Mainly the rich people who have available land and cannot give sufficient time in crop agriculture, practice woodlot as a source of extra income. This paper represents an overview of private woodlot plantation and the findings of the case study of ownership status of private woodlot owners with particular reference to Jessore District of Bangladesh. The objective of the study is to identify the ownership status of private woodlot owners and problems of woodlot plantation. The result shows that 100% owners practice woodlot on their own land. Maximum owners raise woodlot on fallow lands because of less suitability and less production of agricultural crops on such lands. Woodlot owners usually having income level of Tk. 2000-4000 have the highest participation (48.33%) in woodlot plantation. Most of the owners practicing woodlot plantation have educational status below SSC level and primary occupations of maximum woodlot owners are business and other government and non-government services. There is a tendency to practice monoculture because of easy management operations. Wealthier farmers with enough lands and capital at their command often use their agricultural lands instead of marginal lands for tree planting. On the contrary, farmers on small holdings select the fallow, homestead and degraded lands that are unsuitable for growing agricultural crops for woodlot plantation. Therefore, Government should take initiatives to provide free seedlings, loans on easy terms and other subsidies to the small farmers to ensure woodlot plantation.

Introduction

The village forest represents about 2% of the total land area and 11% of the total forest area of the country. According to one estimate, about 44% of the present timber comes from the privately owned village woodlot (Jalil, 1982). According to another estimate, 60% timber and fuelwood come from privately owned village woodlot (Jalil, 1982). Commercial woodlot plantations have been introduced on forestland to meet the fuelwood requirements of local communities. Such plantations are one component of the ADB-funded Nursery Development Project, which was started in 1989 and ended in 1995.

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Today woodlot blocks can be found in the Sal forest of the Modhupur area and elsewhere (Friends of the Earth, Bangladesh, 2002). From 1960 to 1999, plantation programme was carried out in Sal forest under social forestry programme and at that time 26,890 ha. woodlot plantation was established. At present 30,184 ha. woodlot has been established under social forestry programme in Bangladesh (Habib, 2000).

Forest and forest based natural resources are depleting at an alarming rate with increasing population pressure, extreme weather events and global climate change. Therefore, the importance and demand of plantation or afforestation is increasing day by day. Woodlot is also such a plantation program practiced commercially as well as non-commercially especially in the rural areas to meet the demand of fuel wood, timber, cash income and so on. Different authors described nicely various forms/types of woodlot plantation, different aspects and factors, usefulness and to some extent demerits of woodlot plantation. But to identify ownership status of private woodlot owner will be a new idea that is a significant contributing factor for successful woodlot plantation. Consequently, this contributing factor will certainly be supportive for realizing sustainable management of private woodlot plantation in Bangladesh.

Thus, the study is an attempt to identify the ownership status of private woodlot owners including the problems and make recommendations for successful management of woodlot plantation in Bangladesh.

Methodology

Selection of the study area

Since finding out the ownership status of private woodlot owner was the objective, at first the site selection was made purposively. The criterion for selecting site was availability and diversity of private woodlot plantations. The study area was selected keeping in mind that it might provide a distinctive result that could be useful for comparing with the result of other study area as well as for showing a significant result of the study covering all over Bangladesh. Information on this aspect was collected from personal communication with concerned people and own observation of the author. Thus, two Upazilas in the Jessore district were selected for study purpose. Among these one named Chougacha and another Monirumpur where people are practicing different types of woodlot plantation with great effort and in full swing considering various perspectives of their own.

Data Collection

In order to fulfill the objectives set out for this study, relevant information and literature were collected from the two sources: The primary data were collected by conducting a survey work with a well-prepared structured questionnaire. On the basis of reconnaissance survey, a questionnaire was prepared. The questionnaire covered information on: ownership status and pattern of woodlot owner, land use system, demographic and socio-economic profile of owner, household information, total income of owner except woodlot, reason for woodlot plantation, etc.

For this reason, interviewers were selected randomly. Physical visit to the plantation site and then interviewing the respondent completed the questionnaire.

On the other hand, secondary information were collected from the sources like Khulna University library; Seminar library, Forestry & Wood Technology Discipline, Khulna University; Published and Unpublished reports, Newspapers, Regional center, BBS, Jessore, Internet browsing, etc.

Data Analysis The collected data were then analyzed by SPSS (11.5) statistical package software.

Results and Discussions

1. Ownership status of private woodlot owners

Figure 1 shows that 100% of the owner practice woodlot on their own land. Most of the owners said that practice of woodlot is not their main occupation and only in the extra time they take care and maintenance of it and this is possible if they practice woodlot on their own land. Otherwise in case of leased land extra care, time, manpower and investment for the plantation are needed. The study indicates that only rich farmers who have their own land practice woodlot as a source of extra income.

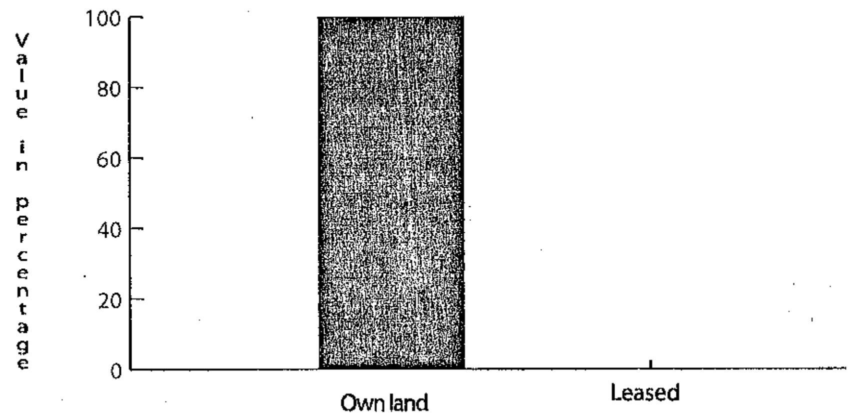

Figure 1. Ownership status of private woodland owner

2. Ownership pattern of private woodlot owners

Figure 2 indicates that 70% of the owners have single ownership of woodlot and the rest of the owners have joint ownership. The main reason for joint ownership of woodlot is joint ownership of land acquired by inheritance.

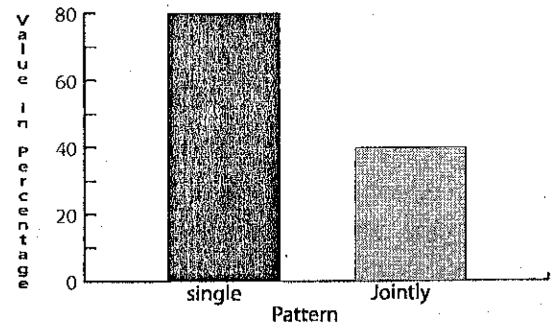

Figure 2. Ownership pattern of private woodlot owners

3. Previous land use system

55% of owners practice woodlot on fallow land in comparison to 40% on agricultural land. The main reason for practicing woodlot on fallow land is less suitability and production of agricultural products on this land (Fig. 3) On the other hand, agricultural land is used for woodlot plantation because the owner can not give proper time for care

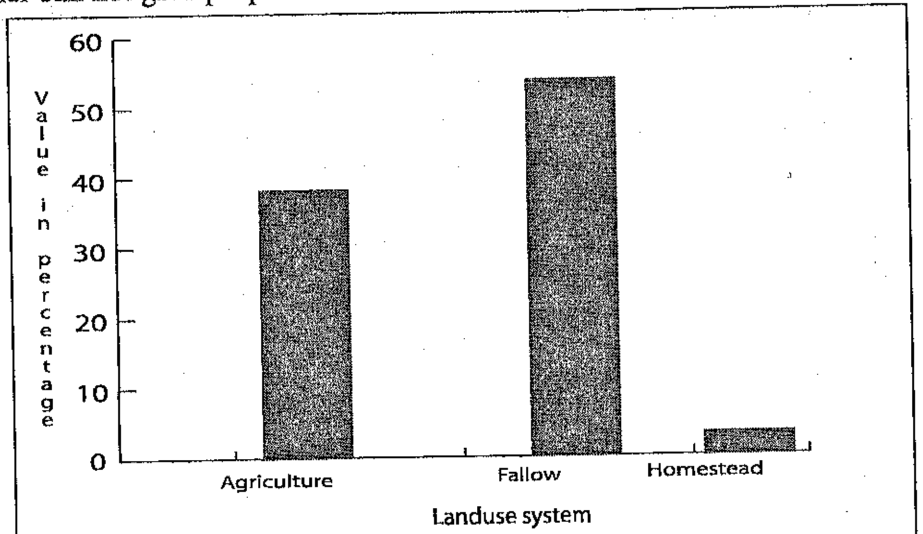

Figure 3. Previous landuse

and maintenance of agricultural products. Other reasons for raising woodlot on agricultural land are reduced soil fertility and more profit at a time. 5% owners practice woodlot on homestead because of easy care and maintenance of plantation.

4. Educational status of private woodlot owners

Figure 4 show that 45% of the owners have educational status below SSC level. As they are not much educated and have no scope of education, they practice woodlot in association with other activities. 30% and 15% owners of woodlot have educational status at HSC and SSC level respectively. The level of participation of SSC - passed owners is less in comparison to HSC passed - Owners. This is because, SSC level owners are mostly engaged in education and are not income earners of the family. On the other hand, HSC- passed owners are mostly engaged in occupation such as business, service, agriculture, etc. and their participation is higher in woodlot plantation. 10% of the owners who have completed graduate degree practice woodlot as an extra source of income.

5. Primary occupation status of private woodlot owners

From figure 5, it is found that primary occupation of maximum 45% woodlot owners is business and 31.66% have primary occupation of government and non-government service. On the other hand, only 23.33% woodlot owners said that their

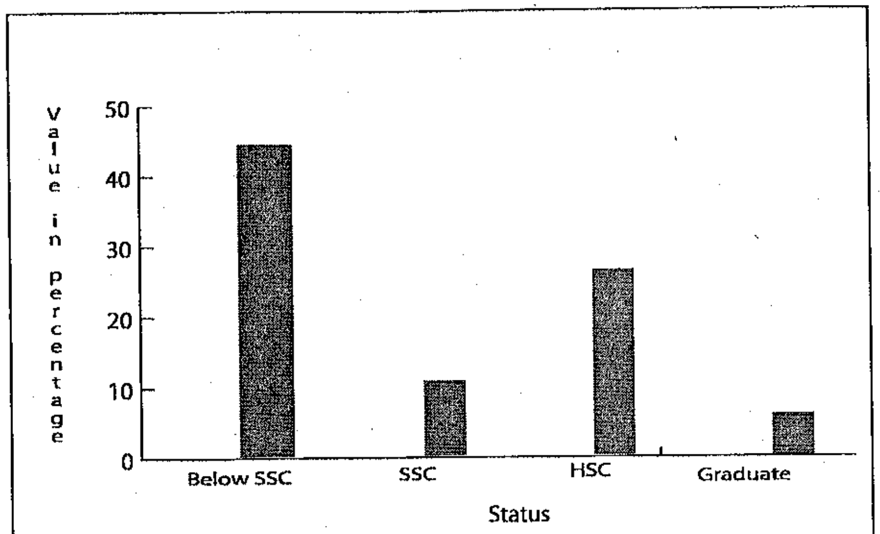

Figure 4. Educational status of private woodlot owners

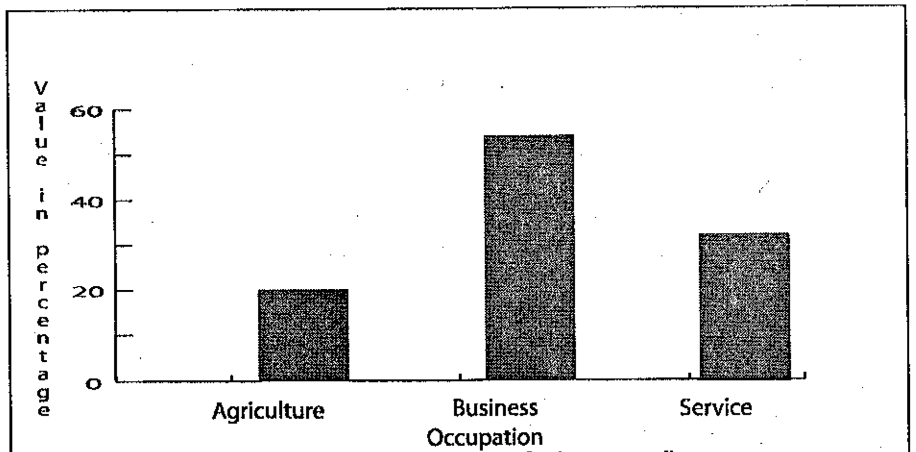

Figure 5. Primary occupation status of private woodlot owners

primary occupation is agriculture and this lowest participation in woodlot is due to land insufficiency. Woodlot owners having business as primary occupation count woodlot as their secondary income source.

6. Total income of the owners per month except earnings from woodlot plantation

The figure 6 represents that woodlot owners having income level Tk. 2000-4000 per month have the highest participation (48.33%) in woodlot plantation. They cannot normally lead a solvent life and, therefore, take woodlot plantation as a means to become solvent in future. 11.66% woodlot owners have income level above Tk. 8000 per month. They are normally rich people and practice woodlot to get some extra output from the plantation e.g. cash, fuel, timber etc. On the other hand, 8.33%, 15% and income level below Tk. 2000, Tk. 4000-6000 and Tk. 6000-8000 per month, respectively. Woodlot owners having income level below Tk. 2000 per month, have the lowest participation in woodlot plantation as they do not have their own land for plantation and normally lead very subsistence lives for whom the plantation program is not profitable at all. Moreover, woodlot owners having income level in the range of Tk. 4000-6000 and Tk. 6000-8000 per month have fallow lands or spare lands on which they can practice woodlot to become solvent in future as well as for security of future generations.

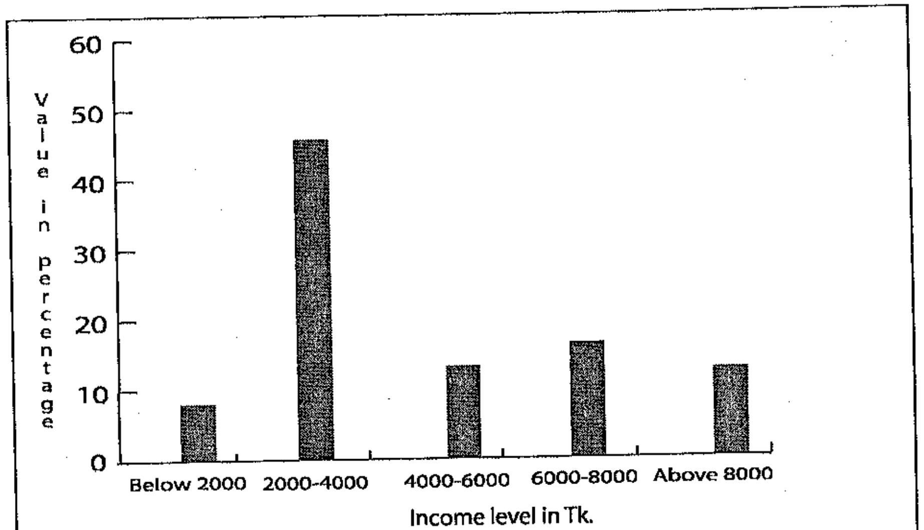

Figure 6. Total income of the woners per month except earnings from woodlot

7. Types of plantation

From figure 7 it is found that 78.33% owners are practicing woodlot which is mono culture. The major reason for this is ease of management 16.66% woodlot owners have Operation. But it has a risk of crop failure by climatic disasters and attack by pests and diseases. On the other hand, 21.66% woodlot is mixed plantation.

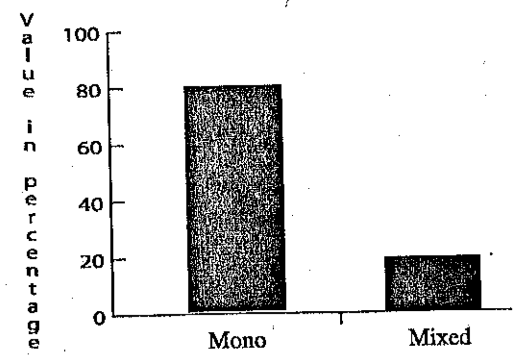

Figure 7: Types of plantation

The most common species used for woodlot plantation in the study areas are:

Sl. No.	Local Name	Scientific Name
1.	Mehagony	*Swietenia mehagony*
2.	Sissoo	*Dlbergia Sissoo*
3.	Teak	*Tectona grandis*
4.	Rain Tree	*Samanea saman*
5.	Akashmoni	*Acacia Auriculiformis*
6.	Eucalyptus	*Eucalyptus camaldulensis*

Sl. No.	Local Name	Scientific Name
7.	Neem	*Azadirachta indica*
8.	Mango	*Mangifera indica*
9.	Jackfruit	*Artocarpus heterophyllus*
10.	Litchi	*Litchi chinensis*

8. Sources of planting materials

95% woodlot owners said that they collect planting materials from nearby markets (Figure 8). Size and healthiness of the seedlings are main considerations for purchase. Only 5% owners collect seedlings from their own nursery. So it can be said that most of the owners are not actively involved with plantation.

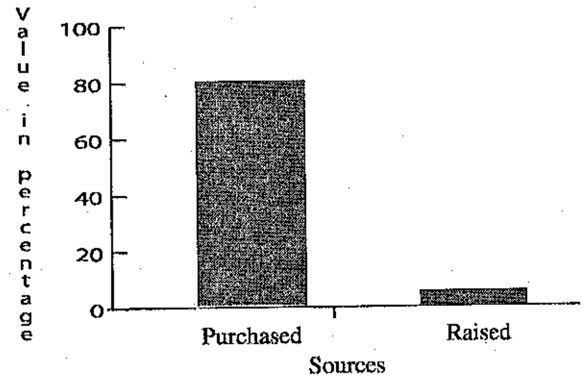

Figure 8 : Sources of plantaing materials

9. Causes of establishment of woodlot plantation

Figure 9 shows that 35% owners are interested to raise woodlot plantation because it is economically profitable and the rest said that it requires low investment. 21.66% owners raise woodlot as it is easily manageable and others practice woodlot on homesteads. Safety of investment is another reason for raising woodlot on their land. 25% owners practice woodlot because they think that it has a less possibility of damage by cattle.13.33% owners practice it because they think that, if they practice woodlot on higher lands, income will be higher than crop production. 5% owners raise woodlot for security i.e. for the solvency of new generation and for household construction.

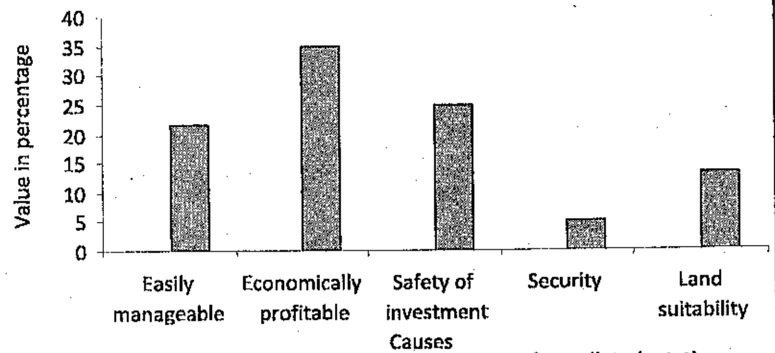

Figure 9: Causes of establishment of woodlot plantation

10. Constraints of private woodlot plantation

Several problems faced by the private woodlot owners are mentioned below:

i. Technical knowledge for successful management of woodlot plantation is not adequate for most of the woodlot owners.

ii. Unequal access to woodlot plantation is a major problem for woodlot plantation in Bangladesh. The poor farmers do not have sufficient land for woodlot plantation.

iii. Most of the woodlot owners do not have knowledge about proper tree species for different land topography.

iv. Long time is needed to get an output from woodlot plantation.

v. In case of monoculture there is a possibility of crop failure because of natural disaster or pest attack.

vi. Unfavorable market condition is an obstacle for commercial woodlot plantation.

vii. In most cases, owners have to collect planting materials from a long distance at high prices.

viii. Most of the woodlot owners do not want to give extra time and labor inputs for woodlot plantation. So they do not get expected returns from the plantation.

11. Recommendations

Based on the discussions above, the following recommendations are made for successful woodlot plantation:

1. Technical know-how and training facilities should be provided to private woodlot owners for plantation.
2. Government would make a shift in the right direction by offering incentives to tree cultivation on marginal and waste lands.
3. Proper marketing condition and marketing facilities would be created for woodlot owners so that they can benefit from the plantation.
4. Tree species that are suitable for a particular area have to be selected for woodlot plantation. Propaganda in this direction should be geared up by proper authorities.

5. Raised and homestead lands that are unsuitable for crop agriculture would be first prioritized for woodlot plantation.
6. Indigenous land use and management practices must be followed carefully.
7. The choice of land used for plantation would be made based on the relative capacity to generate an income compared to other land uses.
8. Planting materials be made available for successful woodlot plantation. Supply of tree seedlings on easy terms to the poor farmers may be an incentive for such plantation.
9. Fast growing tree species should be planted to get a quick return from the plantation.
10. Risk of complete crop failure can be minimized by practicing polyculture suited in that particular area.

Conclusion

Population is increasing at an alarming rate in our country. With the increasing population pressure, the forest and forest related resources are depleting at a dangerous rate. The fallow, homestead and degraded lands that are unsuitable for growing agricultural crops are selected for woodlot plantation by small farmers. However, wealthier farmers with enough lands and capital at their command often use their agricultural lands instead of marginal lands for tree planting. They will be able to take the risk of investing in tree planting and can wait longer for the benefits of tree growing more than the owners of smaller farms. Farmers on small holdings, on the contrary, are often unable to take advantage of the opportunities. A considerable proportion of their land will always be required for subsistence crop production, and it is very likely that there will be little left for woodlot plantation. Therefore, Government should take initiatives to provide free seedlings, loans on easy terms and other subsidies to the small farmers to ensure woodlot plantation.

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Aboveground night time respiration behavior of a mangrove tree Bruguiera gymnorrhiza in Subtropical Okinawa Island, Japan

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Abstract

Aboveground nighttime respiration was measured for 10 sample plants of Bruguiera gymnorrhiza (L.) Lamk. to investigate the size-dependence of the respiratory under field conditions. To measure the respiration of individual plants, the enclosed standing-tree method was adopted. The dependence of the respiration on the tree size was successfully represented by a power function of D0.1H2H. For B. gymnorrhiza the exponent was close to 2/3.

Introduction

Respiration is linked to all the facets of plant metabolism (Amthor 1989). Plant respiratory CO2 efflux is a major physiological process that influences the carbon balance of plant communities and ecosystems. Respiration losses account for a large fraction of fixed carbon in plants and may affect more than photosynthetic rate. To a large extent, it controls productivity in forest ecosystems. It is commonly summarized that up to half or even more of the carbon assimilated by photosynthesis is eventually released through plant respiration (Amthor 1989; Ryan 1991). It is, therefore, important to consider the whole tree in determining the importance of respiration to forest productivity.

Gross production can be defined as the sum of net production and respiration. The net production alone cannot be a reliable measure of potential productivity of a forest stand. The significance of productivity cannot be realized until it is analyzed from the view of the balance between the gross production (gross photosynthesis) and respiration. Hence, respiration measurement is fundamental to the primary production process. Studies of the respiration measurement of woody plants have been made at several biological levels, including tissue (Wullschleger et al. 1995; Ryan et al. 1996), individual (Paembonan et al. 1992; Paembonan and Hagihara 1994) and stand (Yokota and Hagihara 1995; Adu-Bredu et al. 1996a, b). It has been shown that tree respiratory activity changes with time over

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the short term, and several studies have also demonstrated the dependence of respiration on tree size (Ninomiya and Hozumi 1981, 1983a, b; Ogawa et al. 1985; Yokota et al. 1994). All these studies were restricted to terrestrial plant species. Despite potential importance, there is no report on the mangrove respiration. This study attempts to determine the respiratory behavior of Bruguiera gymnorrhiza (L.) Lamk., a mangrove tree species, grown under field conditions.

Materials and Methods

This study was carried out at Manko Wetland, located in the southern part of Okinawa Island, Japan (26^0 11´ N and 127^0 40´ E), registered under the Ramsar Convention . Signatories of Ramsar Convention are bound to adhere to protection of internationally important wetlands (Ramsar Site) as will as "wise use of wetlands" (Shaikh, 2012). The warmth index is 220.4 ^{0}C month, indicating that this area belongs to the subtropical region. The mean monthly minimum temperature of 17.3 C and the mean monthly maximum temperature of 28.9 ^{0}C occurred in January and July-August, respectively. Rainfall was over 100 mm month-1 throughout the year and the mean annual rainfall was 2227 mm yr-1.

Four mangrove species, such as Kandelia obovata Sheue, Liu and Yong, Rhizophora stylosa Griff., Bruguiera gymnorrhiza (L.) Lamk. and Excoecaria agallocha L., are prevalent in the study area. Few distinct monospecific patches of B. gymnorrhiza recently started to show their homogeneous canopies in the process of succession. Within the homogeneous canopies, ten B. gymnorrhiza sample plants of different sizes [to represent whole stand] were selected for the measurement of nighttime respiration.

The respiration of the sample trees was nondestructively measured with an enclosed standing-tree method (Ninomiya and Hozumi 1983a) under field conditions (Fig. 1). The aboveground parts of a sample tree were enclosed in a chamber of 0.1 or 0.2 mm thick polyvinyl chloride film (Takafuji Chemical and Synthetic Co. Ltd., Japan). The skirt of the chamber was tied around the base of the stem and was well sealed with clay. The air in the chamber was mixed by a fan to keep CO2 concentration uniform (air flow more than 0.1 m s-1). Before starting measurement, leak test for 10 min was done to ensure that the chamber is air tight. CO2 concentration within the closed air-circulation system was measured with an infra-red gas analyzer (Carbon Dioxide Probe GMP343, Vaisala, Finland) every five seconds interval for maximum of 10 to 30 min. The CO2 increment in a chamber is illustrated in Fig. 2. The measurement was carried out from May to July 2007. The mean air temperature inside the chamber during the measurement period was 27.8 ± 0.2 (SE) ?C.

Respiration rate r was calculated from the mean CO2 increment in a chamber following the formula,

$$r = V \cdot \frac{273.2}{273.2+\theta} \cdot \frac{P}{1013} \cdot \frac{1}{22.4} \cdot \frac{\Delta C}{\Delta t}$$

where 'r' is respiration rate (ppm CO_2, s^{-1}), `V' is chamber volume (l), is mean air temperature inside

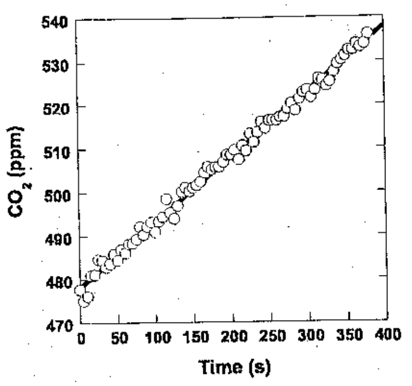

Fig. 1. Schematic diagram of the enclosed standing-tree method (modified from Ninomiya and Hozumi 1983a).

the chamber (C), P is air pressure (hPa) and △C/△t is CO2 increment rate (ppm CO2 s-1) in the chamber.

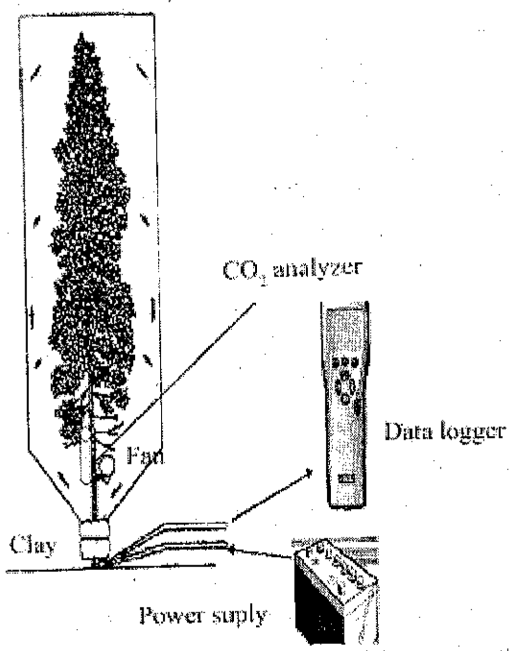

Fig. 2. An example of CO2 increment in a chamber.

Results and Discussion

The power equation was applied to express the relationship between respiration r of a tree (?mol CO2 s-1) and D0.1H2H (cm2 m) of the corresponding tree:

$$r = g \cdot \left(D_{0.1\mathrm{H}}{}^{2}H\right)^{h}$$

where g multiplying coefficient and h is the scaling exponent. The values of g and h respectively were 7.66 x 10-2 ?mol CO2 s-1 (cm2 m)-h and 0.689 for B. gymnorrhiza (Fig. 3). This exponent of 0.689 for B. gymnorrhiza was found to be significantly lower than 1.0, which was expressed by Reich et al. (2006), and also significantly lower than 3/4, which was expressed by West et al. (1997), but the exponent was not significantly different from 2/3 (R2=0.989; P=0.425), which was claimed by Ninomiya and Hozumi, (1983a, b).

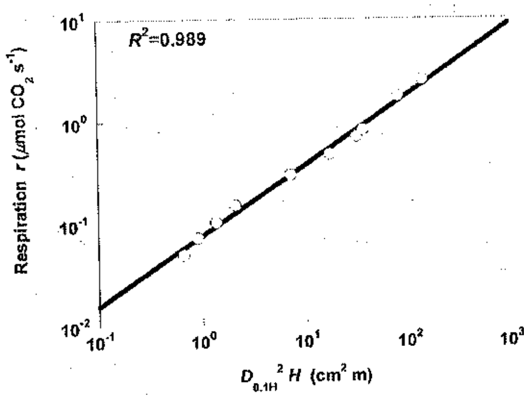

Fig. 3. Relationship between respiration r and D0.1H2H in B. gimnorrhiza trees.

Von Bertalanffy (1957) stated 3 forms of size-dependence of metabolism. The metabolic rate is (1) proportional to surface area w2/3, (2) proportional to mass wT and (3) proportional to one intermediate

between surface area and mass. In the 8-yr-old B. gymnorrhiza stand, the scaling exponent was found to be 2/3, which indicates that the aboveground respiration was proportional to the surface area. High stand respiration with a lower exponent could be attributed to the high density of smaller plants. Ninimiya and Hozumi (1983b) observed similar respiratory nature in a 24-yr-old Chamaecyparis obtusa plantation, where trees were subject to self-thinning. Finkel et al. (2004) reported that deviation from the 3?4 size-scaling exponent for metabolic rate under resource-limiting conditions is the consequence of the size-dependence of both resource acquisition and physiological acclimation to resource availability. Under resource-limiting conditions, organisms need to allocate an increasing proportion of their internal resources and total biomass towards resource acquisition. An increase in the ability to harvest resources with body size might lead to an increase in the size-scaling exponent of individual based metabolic rate, though constraints imposed by the demands of transportation networks will limit this effect. A decrease in the ability to harvest resources with body size will cause a decrease in the size-scaling exponent of individual based metabolic rate, because there is no way for a transportation network to compensate for unavailable resources.

Conclusion

The size-dependence of their respiratory behavior was clear. The size-dependence of respiration of in B. gymnorrhiza could be successfully represented by a power function of D0.1H2H. The exponent was close to 2/3. However, in this paper size of the tree was reprentented by a function of D0.1H2H and solely the dependence behavior is discussed. So, real mass measurement is a prerequisite for estimation of stand respiration (or should it be 'an estimation of stand respiration is a prerequisite for mass measurement' if mass measurement means the mass of the tree?). Further, respiration measurement on different growth conditions, and different seasons are needed for investigating long-term respiratory behavior in relation to environments.

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Potential of Yield Enhancing Quantitative Trait Loci (QTLs) in Rice Improvement

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Abstract

Grain yield, which is governed by quantitative trait loci (QTLs) is one of the most important indices in rice breeding. Wild species of rice are increasingly being used to improve various agronomic traits including yield in cultivars. QTL mapping is a popular and efficient strategy to dissect the genetic basis of rice yield traits such as grain number per panicle, grain weight and tillers per plant. Dense molecular maps have enabled mapping of quantitative trait loci (QTLs) for complex traits such as yield. QTLs for increased yield have been identified from wild relatives of rice. Advanced backcross QTL analysis has been used to identify naturally occurring favorable QTL alleles for yield and to minimize the effect of unwanted alleles from wild species. Yield QTLs from wild species are distributed on almost all chromosomes but more often in some regions. Different mapping populations have been used to explore the QTLs controlling yield related traits. Primary populations such as F_2 *and recombinant inbred line populations have been widely used to discover QTLs in rice genome-wide, with detection of hundreds of yield-related QTLs. Advanced populations such as near isogenic lines (NILs) are efficient to further fine-map and clone target QTLs. To date, 20 QTLs directly affecting rice grain yield and its components have been cloned with NIL-*F_2 *populations, and 14 new grain yield QTLs have been validated in the NILs. Reasonable combination of favorable alleles has the potential to increase grain yield via use of functional marker assisted selection. Many QTLs have been detected in more than one environment and in more than one genetic background. The overall direction of effect of some QTLs however, may vary with genetic context. Thus, there is evidence of stable and consistent major effect of yield-enhancing QTLs derived from wild species in rice. Such QTLs are good targets for use in marker assisted selection though their context-dependency is a major constraint. In this study, the characterizations of different kinds of populations, their QTL information and genetic effect have been reviewed. Literature on yield QTLs mapped from wild species is summarized with special reference to rice. Manipulation of QTLs has immense potential for rice improvement indeed.*

Keywords: Grain yield; mapping population; Quantitative

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Trait Loci (QTL), wild rice, Marker assisted selection.

I. Introduction

Rice is the primary food source for more than a third of the world's population. To meet the growing needs of the ever increasing human population, rice production must be increased continuously. Every effort should, therefore, be directed towards employing all available knowledge to achieve the potential yield of the current varieties. Nevertheless, to achieve such a phenomenal increase in production, new avenues have to be explored to increase the yield of rice per unit area. The foremost prerequisite for such a gigantic endeavour is enhancement and utilization of genetic knowledge to improve the yield potential of varieties. Plant breeders have lately developed some new techniques which have shown better potential than some previous ones. Quantitative Trait Loci (QTLs) analysis is one of such techniques offering immense opportunities for improving agronomic yield components as well as decreasing yield loss through increased resistance against diseases and pests.

A chromosomal region that is associated with molecular markers and with a Quantitative trait (QT) is defined as a QTL. QTs are genetically controlled by effects of polygenes that are greatly modified by environments. Each of these genes potentially has a relatively small effect. With the advent of molecular markers, such as restriction fragment length polymorphisms (RFLPs), simple sequence repeats (SSRs) and single nucleotide polymorphisms (SNPs), high density genetic maps can be constructed and QTs can be associated with molecular markers. Plant populations with different genetic structures have been created for genetic mapping, including F_2 / F_3, Back cross (BC), Double haploids (DHs), Recombinant inbred lines (RILs), Near isogenic lines (NILs), Back cross inbred lines (BILs) and various mutants. In rice, there are 14 permanent populations reported so far, including two DH, nine RIL and one BIL populations (Yunbi 2002). Developments of advanced statistical methods, such as composite interval mapping (Zeng, 1993, 1994; Jansen and Stam, 1994) and Markov chain Monte Carlo analyses (Satagopan et al., 1996; Uimari et al., 1996), along with powerful software (such as MAP MAKER/ QTL, nQTL, Map QTL, WinCart), has contributed to genetic mapping using data collected for multiple traits in different environments.

Since the first QTL studies were done by Ahn et al. 1993 and Xu et al. (1993), more than 80 articles with over 1000 QTL had been documented by 2000. Rice is the first example in monocot species of the successful cloning of the major gene (the bacterial blight resistant gene, *Xa 21*) (Song et al., 1995) and a QTL (Heading date, Hd 1) (Yano et al., 2000) through map based cloning.

II. Population development for QTL study

The confidence interval of a QTL is dependent on the type of population and its size. An F_2 population derived from a cross between two rice plants is easily developed by one crossing and one self-crossing, and

contains the complete genetic information of the two parents. Doubled haploids (DHs) are produced by cultured anthers from an F1 plant derived from two parents. Due to the genotype dependency of anther culture, DH is limited in QTL mapping. Recombinant inbred lines (RILs) are very popular for QTL mapping, and are developed by single-seed descent from a cross between two parents. Unlike the F_2, DH and RIL populations can be planted repeatedly in different seasons or environments to rule out environmental effects and experimental error. F_2, DH or RIL populations are powerful and adequate to fine map qualitative genes if there are plenty of polymorphism markers. The different parental combinations have been used for construction of populations in the last two decades. Populations derived from inter-subspecies crosses between japonica and indica have also been widely used for QTL mapping (Xiao et al., 1996; Yano et al., 2001; Yan et al., 2003; Song et al., 2007; Nonoue et al., 2008). Besides the higher genetic polymorphism, there are larger trait variations in inter-subspecies populations than in intra-subspecies populations, which is a powerful tool in the detection of QTLs. Recently, the high density single nucleotide polymorphism (SNP) map based on next-generation sequencing was developed with the same RIL population and used for grain yield-related QTL mapping. There are probably two factors affecting the resolution of QTL mapping: one is the small size of the mapping population, which limits the recombination events and results in clusters of markers co-segregating; the second is phenotyping precision, which is frequently affected by environmental factors and experimental design.

III. Importance of wild rice in QTL analysis

One of the potential mechanisms is diversification of gene pool. There is thus an urgent need to broaden the rice gene pool by introgression of new genes from diverse sources to meet various challenges affecting rice production. Wild species of *Oryza* are an important reservoir of useful genes for rice improvement. It is, therefore, necessary to enhance the grain yield of rice through introgression of useful alleles of wild relatives in variety development efforts (Brar and Khush 2002). Many agronomically important traits are governed by several genes i.e. quantitative trait loci (QTLs). The identification of important QTL-controlled agricultural traits has been difficult because of their complex inheritance; however, completion of the rice genome sequence has facilitated the cloning of QTLs and their pyramiding for breeding improved varieties. Because QTLs are derived from natural variation, the use of a wider range of variations such as that found in wild species is important (Ashikari and Matsuoka, 2006). Wild species of crop plants are increasingly being used to improve various agronomic traits including yield in cultivars. QTLs for increased yield have been identified from wild relatives of several crop plants (Swamy and Sarla, 2008). Cultivated rice (*O. sativa* L.) is endowed with a rich genetic variability. In spite of such a great diversity, the modern rice cultivars have narrow genetic bases for most of the agronomically important traits.

Wild progenitor species present potential donor sources for complex traits such as yield (Pradeep et al., 2005). With the availability of the complete genome sequence of rice and the developments in the field of genomics, it is now possible to identify the genes underlying the QTLs. The identification of the genes constituting QTLs would help rice breeders to understand the molecular mechanisms behind the action of the QTLs.

Over the last decade, wild species in rice have been successfully utilized for introgression of traits such as yield and its components into cultivars (Moncada et al., 2001; Brondani et al., 2002; Septiningsih et al., 2003; Thomson et al., 2003). In the first ever report on the use of wild species for introgression of quantitative characters, two yield QTLs, *yld 1.1* and *yld 2.1*, each of which is capable of increasing yield by about 18% have been identified in a Malaysian accession of *O. rufipogon* (Xiao et al., 1998; Xiong et al., 1999).

Wild progenitors of rice constitute an important gene pool for its improvement and have traditionally been used as sources of disease and pest resistance. Molecular mapping has shown that phenotypically poor wild species can contribute genes for improving complex traits such as yield. This has led to a paradigm shift from looking at the phenotype to looking at the genotype (Kaladhar et al., 2008). Yield and related QTLs have been identified from wild rice species *O. rufipogon, O. grandiglumis* and *O. glumaepatula* (McCouch et al., 2006; Swamy and Sarla, 2008; Yoon et al., 2010). Mapping of yield enhancing QTLs from *O. nivara* results indicate that there are many *O. nivara* QTL alleles which have the potential to increase yield of rice variety Swarna (Kaladhar et al., 2008).

In rice, several workers have used RFLP and SSR markers to monitor yield and quality related traits from *O. rufipogon* (Thomson et al., 2003; Septiningsih et al., 2003 a, b) or from other wild species such as *O. glumaepatula* (Brondani et al., 2002) or *O. glaberrima* (Jones et al., 1997; Lorieux et al., 2003) into cultivated *O. sativa* back grounds. To understand the genetic characteristics of the traits related to differentiation between cultivated rice and its wild progenitor, genetic factors controlling yield related traits were identified using a BC_3F_2 population derived from *O. rufipogon* Griff., collected from China and an Indica cultivar Teqing (*O. sativa* L). By single point analysis and interval mapping, 59 putative QTLs those influence11 quantitative traits were detected at two sites and 37.5% of the QTL alleles originating from *O. rufipogon* had a beneficial effect for yield related traits in the Teqing background. Regions with significant QTLs for yield related traits were detected on chromosomes 1, 4, 5, 7, 8 and 12 (Lubin et al., 2008). They found that three quantitative morphological traits, plant height, awning, and seed shattering are controlled by major QTLs with large increasing effects associated with the *O. rufipogon* alleles. In an analysis of key domestication traits, Li et al., (2006a) identified a region on chromosome 7 that contains a QTL with a large effect on plant height, panicle length, primary branch number and spikelet number. They proposed that fixation of a mutation on chromosome 7

may result into substantially improved plant architecture and desirable panicle structure.

The opinion that Asian cultivated rice (*O. sativa* L.) originated from common wild rice (*O. rufipogon* Griff.) has been supported by morphological, biochemical and genetic studies (Oka 1974, 1988; Sano and Sano, 1990; Morishima et al., 1992; Wang et al., 1992 and Sun et al., 2001). Clear differences have been noted between cultivated rice and *O. rufipogon* with morphological, physiological and isozyme markers and the genetic basis of these differences have been investigated by QTL analysis (Xiong et al., 1999; Cai and Morishima, 2002; Lee et al., 2005 and Li et al. 2006a). Sun et al. (2001) compared the genetic diversity of common wild rice with that of cultivated rice using RFLP markers, and the results indicated that the number of alleles of cultivated rice was only 60% of that of wild rice. Therefore, it is very important to utilize the wild ancestors of crop plants as sources of genetic variation that have been lost during the process of domestication (Sun et al., 2001; Zamir, 2001). Recently, several investigations have been performed to identify and introduce trait enhancing alleles from wild species into high yielding elite cultivars by advanced backcross approaches (Xiao et al., 1998; Moncada et al., 2001; Li et al., 2002; Thomson et al. 2003 and He et al., 2006).

IV. Identification and introgression of yield enhancing QTLs from different wild species of rice

Wild species are phenotypically inferior to the cultivated species. But recent findings have shown that the wild species contain genes capable of improving the yield as well. Deleterious genes often mask these favourable genes. Transgressive segregation for yield in crosses of cultivated and wild species suggests that despite inferior phenotypes, wild species contain genes that can improve quantitative traits such as yield. Molecular markers have made it possible to identify and introgress desirable QTLs from wild species into elite breeding lines (Brar and Khush, 2002). Tanksley and Nelson (1996) proposed advanced back cross QTL analysis to discover and transfer valuable QTL alleles from unadapted germplasm, i. e. from wild species into elite lines of species. The accession IRGC 105491 (*O. rufipogon*) was used as the wild rice donor in 4 parallel wild rice QTL studies (McCouch et al., 2001). The QTL results using this accession as a donor parent and different elite varieties as the recurrent parents have been compared by Septiningsih et al. (2003), who indicated that the same *O. rufipogon* derived alleles give similar effects in different cultivar backgrounds and environments. However, they also indicated that other alleles from the same accession of wild rice are influenced by genotype x genotype or genotype x environment interactions, and behave differently in different genetic backgrounds and environments.

In addition, several QTLs for yield-related traits were detected in similar chromosomal regions of different types of wild rice, but the genetic effects were completely different. For example, one QTL (kgw2.1) for grain weight near the SSR marker RM250 on the long arm of chromosome 2 was detected in YJCWR, IC22015 (Marri et al., 2005), and IRGC 105491 (Septiningsih et al., 2003; Thomson et al. 2003). The alleles derived from YJCWR and IC22015 increased grain weight, while the alleles derived from IRGC 105491 decreased grain weight. One negative QTL (gpp3.1) for grains per panicle in the interval OSR31-RM130 on the long arm of chromosome 3 was detected in both YJCWR and IC22015 (Marri et al. 2005), while the same chromosomal region was associated with a positive QTL for grains per panicle in IRGC105491 (Thomson et al., 2003). This indicates that the allele derived from IRGC 105491 is superior to those from YJCWR and IC22015. QTL from wild species of rice for increased yield have been identified. Xiao et al. (1996) analysed 300 BC_2 testcross families produced from the cross of *O. sativa* x *O. rufipogon.* On average, each BC_2 test-cross line contained 5% *O. rufipogon* genome. In most cases, introgression of *O. rufipogon* alleles either had no significant effect on yield or was inferior to the alleles of cultivated rice. *O. rufipogon* alleles at two marker loci, RM5 *(yld1-1)* on chromosome 1 and RG256 on chromosome 2 *(yld2-1)*, were however, associated with enhanced yield. The alleles *yld1-1* and *yld2-1* were both associated with a significant increase in grains per plant. In another experiment Xiao et al. (1998) identified 68 QTLs. Of these, 35 (50%) had trait improving alleles derived from the phenotypically inferior wild species. Nineteen (56%) of these beneficial QTL alleles had no deleterious effects on other characters.

V. Impact of the rice genome sequence

Grain yield in rice is a complex trait multiplicatively determined by its three component traits: (i) number of panicles per plant, (ii) number of grains per panicle, and (iii) 1000 grain weight. All of these are typical quantitative traits. The developments in genome mapping, sequencing, and functional genomic research have provided powerful tools for investigating the genetic and molecular bases of these quantitative traits. Dissection of the genetic bases of the yield traits based on molecular marker linkage maps resolved hundreds of QTLs for these traits (Xing and Zhang, 2010).

Genomics research has been generating information about the location and phenotypic consequences of specific genes and alleles in a wide range of species. DNA sequence information greatly accelerates the development of molecular markers. Gramene is a comperative genome database for grasses and currently offers a complete inventory of all published QTL that have been identified in rice (www.gramene.org/qtl/index.html), allowing users to find information about where along the chromosome a QTL is located, what phenotype is associated with the QTL, how it was measured, what germplasm was used, what molecular markers reside nearby, what the corresponding position is on a comperative map of another grass species and with what statistical significance the QTL was detected. In a breeding context, many different lines or crosses must be carefully analyzed over different years and environments to unravel important components of gene interaction. Understanding the genetic basis of genotype by genotype interaction (G x G) and genotype by environment interaction (G x E) is critical as the basis for predicting how

QTL are likely to behave. Once gene and QTLs are identified, markers allow interesting alleles to be traced through the pedigrees of breeding programmes or mined out of germplasm collections to serve as the basis for future varietal improvement endeavours (Jeremy and Susan, 2007). Yield QTLs from wild species are distributed on almost all chromosomes but more often in some regions. QTLs for highly correlated yield associated traits are also often co-located implying linkage or pleiotropic effects. Many QTLs have been detected in more than one environment and in more than one genetic background. There is evidence of deriving stable and substantially consistent yield enhancing QTLs from wild species of several crops (Swamy and Sarla, 2008).

VI. Advanced backcross QTL analysis

Advanced backcross QTL analysis has been used to identify naturally occurring favorable QTL alleles for yield and minimize the effect of unwanted alleles from wild species (Swamy and Sarla, 2008). Advanced backcross QTL analysis (Tanksley and Nelson, 1996) can be used to evaluate mapped donor introgressions in the genetic background of an elite recurrent parent. Using this approach, specific regions of the genome derived from either wild or adapted sources of germplasm and tagged with molecular markers can be associated with the performance of segregating offspring. In a study, it was demonstrated that QTLs derived from *O. rufipogon* (IRGC#105491) were associated with yield enhancement and earliness in an elite hybrid variety from China evaluated under high input conditions (Xiao et al., 1996, 1998).

Moncada et al. (2001) followed the advanced backcross breeding strategy and analysed BC_2F_2 populations derived from the cross involving an upland japonica rice cultivar, "Caiapo" from Brazil and an accession of *O. rufipogon* from Malaysia. The populations were tested under a drought prone and acid soil conditions. Based on analysis of 125 SSR and RFLP markers, using single point, interval and composite- interval mapping, two putative *O. rufipogon* derived QTLs were detected for yield, 13 for yield components, four for maturity and six for plant height. Advanced-back-cross QTL analysis showed that certain regions of the rice genome harbour genes that are useful across a range of environments. While the indica and japonica subspecies are separated by a partial sterility barrier, both cross readily with most accessions of *O. rufipogon.* The possibility of selectively introgressing useful genes from *O. rufipogon* to elite rice cultivars suggests a way of improving the performance of *O. sativa* while simultaneously broadening the genetic base of cultivated rice (Xiao et al., 1998).

A BC_2F_2 population developed from an interspecific cross between *O. sativa* (cv IR64) and *O. rufipogon* (IRGC 105491) was used in an advanced backcross QTL analysis by Septiningsih et al., (2003). A total of 165 markers consisting of 131 SSRs and 34 RFLPs were used to construct the genetic linkage map. By employing interval mapping and composite interval mapping, 42 QTLs were identified. Among them 20 QTLs (47.6%) were exclusively detected uncovering potentially novel alleles from the wild, some of which might improve the performance of the tropical indica variety IR64.

VII. Genotype-by-environment (G x E) interaction analysis

The phenotype of an individual is affected both by genotype (G) and environment (E). Most agronomically significant characters are inherited quantitatively and are known to be affected by environmental factors. Selection based on the phenotype would be difficult for such traits. Yield contributing traits such as number of panicles per plant, number of grains per panicle and 1000 grain weight influence the yield directly and are affected by environment. While the mapping of QTL traits has been reported by several workers, there are not many reports on the identification of the QTL in one mapping population across several environments. Most of the investigations have identified QTL either in two or three environments (Paterson et al., 1991; Stuber et al., 1992; Hayes et al., 1993; Zhuang et al., 1997; Shailaja et al., 2002) or used more than one population in same location (Lin et al., 1995) or in one population in single environment (Wang et al., 1994; Champoux et al., 1995; Li et al., 1995; Xiao et al., 1996; Hemamalini et al., 2000). When the same mapping population is phenotyped in different environments, some QTL could be detected in one environment but not in others. Shailaja et al., (2003) conducted a study with the doubled haploid lines of an IR64 /Azucena rice cross in nine environments in Asia. QTL controlling 11 growth and yield traits in rice were identified by them together with common QTL across different environments. They estimated the G x E interaction on the growth traits, grain yield and yield contributing traits.

VIII. Importance of QTL mapping for Marker Assisted Selection (MAS)

The most promising application of DNA markers in breeding for cultivar development is Marker Assisted Selection (MAS). MAS refer to the use of DNA markers that are tightly linked to target loci to assist phenotypic screening. By determining the allele of a DNA marker, plants that possess particular genes or quantitative trait loci (QTLs) may be identified based on their genotype rather than their phenotype (Bert and Mackill, 2006). The effective utilization of molecular marker technology and QTL management in breeding programs depends on tight linkage between markers and QTL (Dudley, 1993).

The identification of genes and QTLs and DNA markers that are linked to them is accomplished via QTL mapping experiments. QTL mapping thus represents the foundation of the development of markers for MAS. There are many factors that influence the accuracy of QTL mapping such as population size and type, level of replication of phenotypic data, environmental effects and genotyping errors. These factors are particularly important for more complex quantitative traits with many QTLs, each with relatively small effects (e. g. yield). Therefore, in recent years it has become widely accepted that QTL confirmation, validation and additional marker testing steps may be required after QTL mapping and prior to MAS. The effect of a QTL may depend on the genetic background.

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This emphasizes the importance of testing the QTL effects and the reliability of markers before MAS is undertaken (Bert and Mackill, 2006). The use of a common set of molecular markers made it possible to determine whether QTLs from all the different studies were in similar regions of the rice genome. By doing so, newly reported QTLs could be compared to previously reported QTLs, lending legitimacy to those with a prior history and suggesting caution for those flagged for the first time (Moncada et al., 2001). Introgression lines developed from wild species in combination with Marker Assisted Selection should facilitate efficient gene identification (Ashikari and Matsuoka, 2006).

IX. Conclusions

Molecular marker technology has revolutionized our understanding of quantitative traits under different backgrounds at different levels of genomics. In the 21st century numerous developments in science and technology have been started to manipulate genes for both qualitative and quantitative traits. Using marker trait association, for example, MAS can now help plant breeders manipulate traits that are difficult or impossible to handle in conventional breeding. As a major food source for human beings and a model plant for molecular biology, rice has been moving well ahead of other plants in QTL analysis. In the future, more attention should be paid to transgenic (gene plus) and knockout (gene minus) mutant analysis, G x E interaction, epistasis and developmental genetics for complicated traits and trait components. With the techniques currently available, it takes years to clone a gene using map based cloning.

However, the lack of significant phenotypic effect for numerous QTL will greatly challenge our current systems. Additional research is, therefore, urgently needed to map, clone and better characterize QTL. In particular, we need to be able to map mutant genes to a small interval more efficiently. Therefore, the development of an ideal and efficient system for QTL analysis in the area of functional genomics is critical for all plants. Highly informative markers, isogenic mutation libraries, high throughput technology, powerful statistical methods and computational software are key tools for the genetic manipulation of QTL. With all the technical developments, manipulating quantitative traits in the near future could be easier which, in turn, is expected to expose the full potential of QTL analysis for plant improvement.

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Influence of Food Production on Food Habit: A case of Bangladesh

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Abstract

The nature of productivity of food crops and peoples' choice of food has been compared in six different regions of Bangladesh to determine influence of productivity environment on food choice of people. The gender bias of food choice has also been studied. The findings suggest that the productivity environment has strong influence in food habit. However, there are other forces like market dynamics and social tradition that could have influence on gender difference of food choice.

Key Words:
Vegetarian, Non-vegetarian, Food, Productivity, Tradition, Agriculture

Introduction

Bangladesh is one of the most vulnerable countries to the impacts of global climate change. Impact of changes are observed through increasing temperature, changes in patterns of natural disturbances such as flooding, changes in the frequency and intensity of rainfall and increasing frequency of storms of hurricane intensity, saline water intrusion and sea level rise. All these impacts are affecting food security of the country. One of the means of adapting climate change impacts is to change in the pattern of food consumption. The changes in the course of food habit that would well-suit the circumstances of climate change could be anticipated well if the relationship of productivity environment on food habit is well-understood. Story et al. (2002) observed that eating behavior, particularly at an adolescent stage, is a function of individual and environmental influences. Based on social cognitive theory and ecological perspectives the authors have outlined four levels of influence in food habit which include individual or intrapersonal influences (e g., psychosocial, biological), socio-environmental or interpersonal (e.g., family and peers), physical, environmental or community settings (e.g., schools, fast food outlets, convenience stores), and macro-system or societal (e.g., mass media, marketing and advertising, social and cultural norms).

It is obvious that availability of food crops is dependent on the diversity of species in a particular area. Market is also likely to respond to the community settings and

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cultural needs. As a result it is likely that climate related changes are likely to impact the food habit in multiple directions.

It has been predicted that about 925 million people in the developing world do not have enough to eat, which represents almost 16 percent of the population of developing countries (FAO, 2010). The number of undernourished people in the world remains unacceptably high at near the one billion mark. The recent trend of increased food prices will create additional obstacles in the fight for climate adaptability through changing food habit. Droogers (2004) studied even further that about 41 million people in the industrialized countries and countries in transition also suffer from chronic food insecurity. Thereby the question remains whether we will be able to produce sufficient food in post - climate situation, as well as whether we will be able to cope up with problems market distribution of foods due to changing situations and demand pressure. On top of this there will be impacts of climate change situations on environmental changes that might be associated to many other uncertainties related to food production, storage and consumption (James et al., 2010). However, environmental problems like climate change are not regarded as a local issue rather a global issue. Considering so, most of us now comprehend that it is important to plant trees, cut off carbon emission, recycle paper, turn off unnecessary electricity, use more solar and wind energy, conserve gas, pollute less and decontaminate our rivers, ponds and streams. But even after being these consciousnesses about the environment, we, however, knowingly or unknowingly have failed to correlate our eating habits with the environment. In accordance with this view Thapaliya (2008) expresses that our eating habits and the environment, though two different things, are deeply correlated. It is human nature to select healthy food for ourselves; but while doing so we have failed to understand how much our food choices also affect the health of the planet Earth. Thus, the threats to the planet of modern production and consumption patterns are subject to considerable debate.

The aim of this study is, therefore, to look at some factors related to environmental changes that could have influence on social bases of food choice. The basis of this aim is that food production and distribution depends on social choice. However, subsequently it is the production and distribution of foods that could be affected by the change of environment. Therefore, the mutuality of social choice and environmental influence will contribute significantly on food related adaptability of human population. Specifically in this article we have attempted to see the relationship of food habit with productivity in Bangladesh. Although rice is the staple in Bangladesh, we have weighted the dominance of choices of other components of foods with rice meals to correlate the productivity.

Brief Environmental Background of Bangladesh

According to geomorphological history of Bangladesh the formation and growth of the Bengal Basin is directly related to the origin and morphology of the Indo- Gangetic trough, which itself is overlaid and filled by sediments thousands of meters thick. The floor of the Bengal Basin consists of quaternary sediments deposited by the Ganges, the Brahmaputra, and the Meghna rivers, known together as the GBM river system, and their numerous tributaries and distributaries. The sediments are washed down from highlands on three sides of the Basin, particularly from the Himalayas, where the slopes are steeper and the rocks are less consolidated. The whole country is consists of mainly low and flat land, except for the hilly regions in the northeast and southeast. A network of rivers, with their tributaries and distributaries, crisscross the country.

Physiographically the country can be divided into hills (e.g. Chittagong and Sylhet,) uplifted land blocks in the northern part (e.g. Thakurgaon and Rangpur,) and the majority alluvial plains of central and southern region (e.g. Dhaka and Chandpur) with very low mean elevation above sea level. The physical environment of Bangladesh is diverse, and there is a mix of both traditional and modern methods of land use, all very closely adapted to the heterogeneous conditions. This complexity of edaphic environment and utilization patterns has important implications for the vulnerability and depletion of natural resource base that could eventually lead to diminished food production both in quality and quantity.

Moreover, neither the physical environment nor technologies remain static. For example, rapid and frequent natural changes are common in the river systems. The rivers are also subject to influences of various human interventions to meet their essential needs on the one hand and commercial greed on the other. Thus, there are dynamic changes taking place in the hydrological system all the time. Except two rivers in south eastern region, the Sangu and the Matamuhuri, all major rivers of Bangladesh have originated beyond the border of the country. As a result, river based hydrological system is beyond the control of the country and is highly uncertain. This uncertainty has a huge influence on land use patterns and productivity of Bangladesh.

In addition, Bangladesh has a comparatively low natural resource base, but a high growth rate of population. The population mainly depends on the natural resource base for their livelihood. But now the resource base is under serious threat, as many natural resources are either being over- exploited or used sub-optimally. Besides the effects of anthropogenic stresses and the agricultural land-man ratio (0.06 ha), the country is further threatened by frequent natural hazards and climate change related uncertainties. Thus, for the survival of Bangladesh's dense population, it is essential to have environmental and social management planning that conserves and sustains the ecosystems to support their foods, livelihoods, economic development and quality of life (Anon, 2011).

Methodology

According to social cognitive theory and ecological perspectives, the social bases of food choice are usually related to gender, age, income, culture, family structure, geographical distribution and availability of food (Stroebele, et al., 2004). Based on these understandings, a plan was made to

investigate food choices of people covering different physiographic localities of Bangladesh along with gender differences. A questionnaire was prepared to survey the food choices of different age groups of different gender in selected locations of Bangladesh. Six locations were selected from six districts of Bangladesh namely Chandpur (Central Eastern area), Chittagong (South Eastern area), Dhaka (Central area), Rangpur (Northern area), Sylhet (North Eastern area) and Thakurgaon (North western area). The locations are shown in the map presented in figure-1.

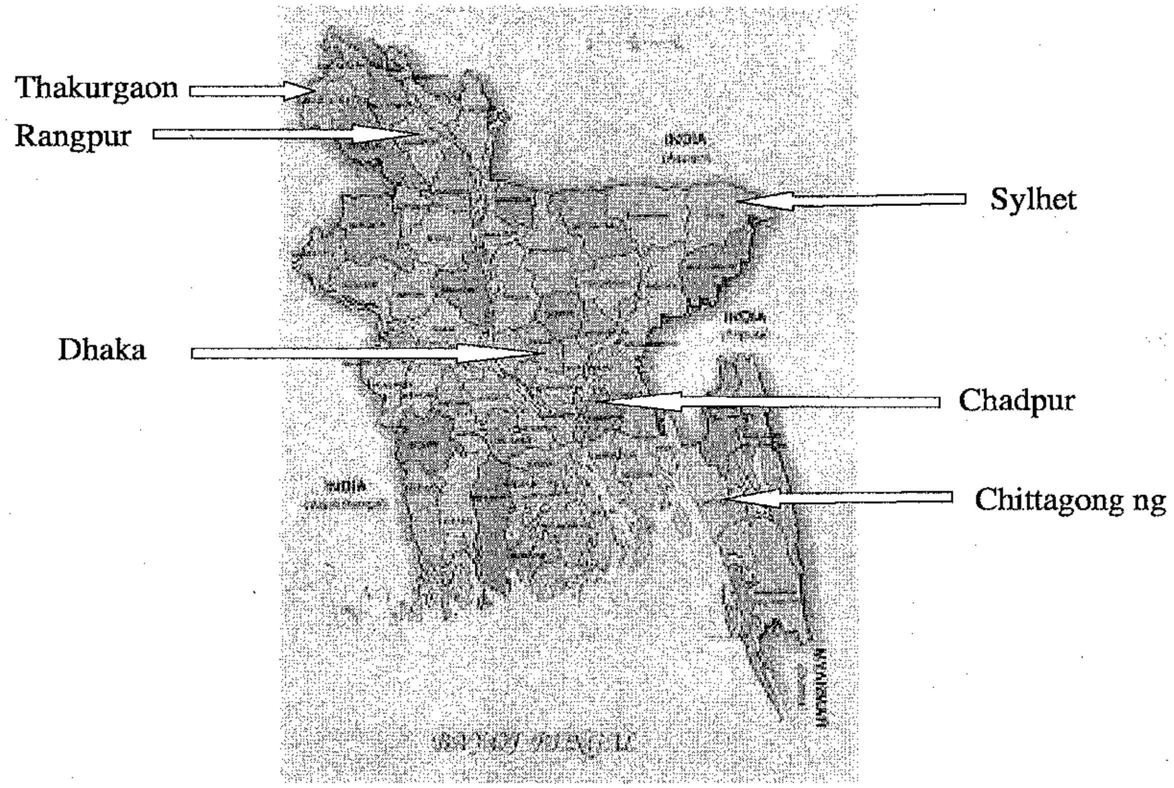


Figure 1: Physical Map of Bangladesh showing distribution of sampled areas
Source: Online Physical Map of Bangladesh 2011

The survey was conducted using the questionnaire from March 10, 2011 to April 20, 2011. The questionnaire was equipped with questions to have information on food habit like vegetarian (based on their major food intake - not true vegetarian) and non-vegetarian people of selected districts, their gender and their location. There were a total of 203 respondents, among them 51 were vegetarian and 105 were non- vegetarian. Data analysis was done using Microsoft Office tools. In addition the agricultural productivity of the selected region was recorded from secondary sources like Statistical Yearbooks of Bangladesh (BBS). The findings are presented in the following result and analysis section.

Results and Discussion

In general, the main crop produced in Bangladesh is rice. Column 2 of the Table 1 shows that rice is produced in all areas. In the same column we find that the major crops produced are almost the same; what is produced and how much, depends on the choice of food and market demand. In the following sections we analyzed if there was any relationship between food habit and productivity.

Nature of Productivity

According to Bangladesh Bureau of Statistics, the main agricultural products of all over Bangladesh is dominated by items like rice, wheat, sugarcane garlic, onion, vegetables, eggs and milk (Table-1). In Chandpur about 141,202 ha area produces 3, 10,575 (M. Ton) rice, 5236 ha area produces 9,610 (M. Ton) wheat, 3233 ha area produces 38,243 (M. Ton) vegetables, 1,056,682 ha produce 6,02,421 (M. Ton) egg, 3.23 ha produces 4,056 (M. Ton) milk and 9191 ha produces 54,641 (M. Ton) fish.

Table 01: Agricultural Productivity Regimes of Selected Regions

Area	Major Crops	Rice (M Ton)	Wheat (M Ton)	Vegetable (M Ton)	Fish (M Ton)	Egg (M Ton)	Milk (M Ton)
Chandpur	rice, wheat, sugar cane, garlic, onion, and vegetables	3, 10,575	9,610	38,243	54,641	6,02,421	4,056
Dhaka	rice, wheat, sugar cane, vegetables, garlic, onion and turmeric	7,25,081	1753	1,01,331	47,299	1,80,71,593	63,207
Rangpur	rice, wheat, pulse, sugar cane, vegetables, garlic and onion	4, 84,247	5,924	1,15,834	5,476	1,129	595
Sylhet	rice, vegetable, onion and turmeric	61,49,167	559	42,230	17,078	24,01,697	227
Thakurgaon	rice, wheat, sugar cane, vegetables, garlic, turmeric, onion	2,69,750	1,04,816	47,254	3,611	3,697	617

Source: Bangladesh Bureau of Statistics

The productivity for Chittagong region is not available. However, the chief agricultural products of the Chittagong region are rice, betel leaf, potato, cotton, tea, peanut, mustard, patol (heap), egg plant, ginger, bean and other vegetables. The area also provides substantial amount of the nation's fruits including but not limited to mango, jackfruit, pineapple, guava, coconut, betel nut, litchi, banana, papaya, water melon and lemon. Agriculture provides 57% of the Divisions' revenues (Anon 2011.) In addition, Chittagong Division produce huge amount of Marine fish in raw and dry forms.

Similarly, the main agricultural products of Dhaka district is rice, wheat, sugarcane, vegetables, garlic, onion, eggs, milk, and turmeric. In Dhaka, 11,94,247 acre produce 7,25,081 (M. Ton) rice, 3,859 acre area produce 1753 (M. Ton) wheat, 43,873 acre produce 1,01,331 (M. Ton) vegetable, 450 acre area produce 1,80,71,593 (M. Ton) egg, 63,207 (M. Ton) milk and 5,742 acre also cultivate 47,299 (M. Ton) fish. Consequently, the main agricultural product of Rangpur district is rice, wheat, pulse, sugar cane, vegetables, garlic and onion. In Rangpur, 3, 65,206 acre produce 4, 84,247 (M. Ton) rice, 10,388 acre produce 5,924 (M. Ton) wheat, 28,441 acre produce 1, 15,834 (M. Ton) vegetables, 1,129 (M. Ton) egg, 595 (M. Ton) milk and 4,666 acre cultivate 5,476 (M. Ton) fish.

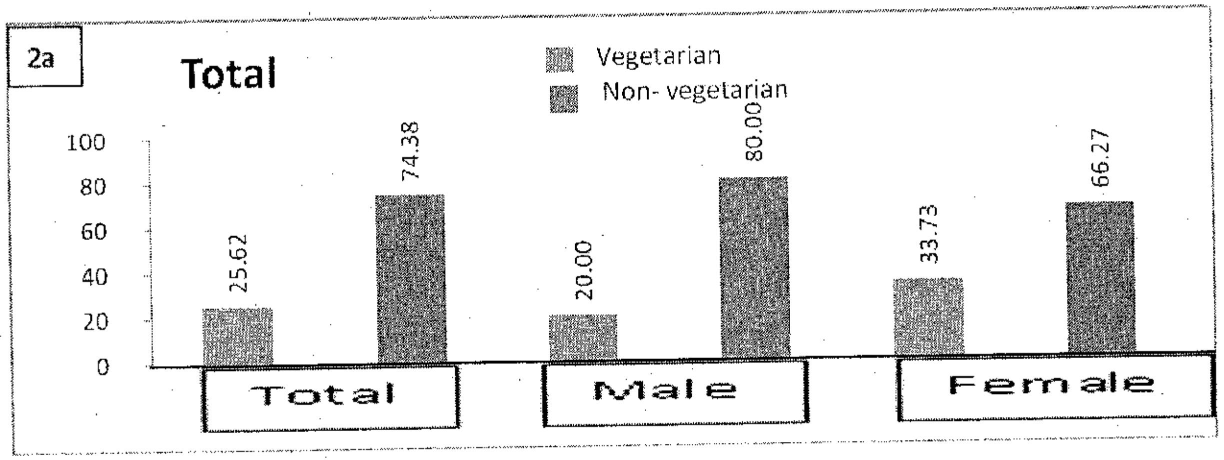
The main agricultural product of Sylhet district is rice, vegetable, onion and turmeric. In Sylhet 4,79,267 acre produce 61,49,167 (M. Ton) rice, 712 acre area produce 559 (M. Ton) wheat, 17,574 acre produce 42,230 (M. Ton) vegetable, 80,525 acre produce 24,01,697 (M. Ton) egg, 43,100 acre produce 227 (M. Ton) milk and 1,14,999 acre cultivate 17,078 (M. Ton) fish. Furthermore, the main agricultural product of Thakurgaon district is rice, wheat, sweet meat, sugar cane, vegetables, garlic, turmeric, onion, eggs and milk. In Thakurgaon 3, 20,666 acre area produce almost 2,69,750 (M. Ton) rice, 1,12,267 acre area produce 1,04,816 (M. Ton) wheat, 21,513 acre area produce 47,254 (M. Ton) vegetables, 3, 2 acre area produce 3,697 (M. Ton) egg, 9 acre area produce 617 (M. Ton) milk and 6,093 acre cultivate 3,611 (M. Ton) fish (Anon 2007.)

The details of meat production are not available. However, Azharul et al. (2005) have reported in 1998-99 that total meat production in Bangladesh was 656,000 tons, of which chicken and duck meat contributed 154,000 tones ranking second after beef production. From the productivity of egg and milk given in the table we can anticipate the regional distribution of Beef and poultry production in Bangladesh. Overall in average per capita meat consumption is only 5.12 kg per year and per capita protein intake 63g per day, which is markedly below recommended requirements. As protein intake is recommended to be in the range of 0.8 to 1.6 g/d per kg body weight for humans, this requires 56 to 112g protein per day for a person of 70 kg body weight. Thus there is a need to increase the animal protein production to fulfill the demand of the people and subsequently to make them sound and healthy for increasing their working ability (Azharul, et al. 2005.)

Food Preference:

The graphs in figure 02 represent the findings on food preference in the form of vegetarian and non-vegetarian food habit in the six districts of Bangladesh. Figure 2(a) shows that overall the proportion of vegetarian are much less (25.6%) than that of Non-vegetarian (74.4%). However, if they are segregated on the basis of gender, the male vegetarian to non-vegetarian ratio is 20% to 80% where as in case of female the same is 33.7% to 66.3%. This means that females are more attracted to vegetable diet than that of the male. This could be resulted from a social custom that the females are tempted to feed their counterpart male with more nutritious food - a dedication inbuilt in socio- cultural system (Azharul 2005).

From the area-wise distribution of food choice, it appears that the ratio of vegetarian (veg) and Non-vegetarian (non-veg) groups in combined gender of Chandpur and Chittagong areas closely follow the overall trend with Chandpur district having 26.7% to 73.3% and in Chittagong district having 23.3% to 76.7%. However, from gender based distribution of food choice of those two areas, it appears that they do not follow the overall trend. In Chandpur area the vegetarian are more (66.7%) than non-vegetarian (33.3%) in the male group (Fig-2b) as opposed to 20% and 80% (Fig-2a) of the corresponding distribution in overall group. In Chittagong area the male ratio of veg and non-veg is 27.8% to 72.2% respectively. Why the male of Chandpur region are more inclined to vegetarian meals are not very clear. The female group ratio of veg to non-veg is 16.7% to 83.3% which is closely matched with the female group of Chittagong (Fig 2c).



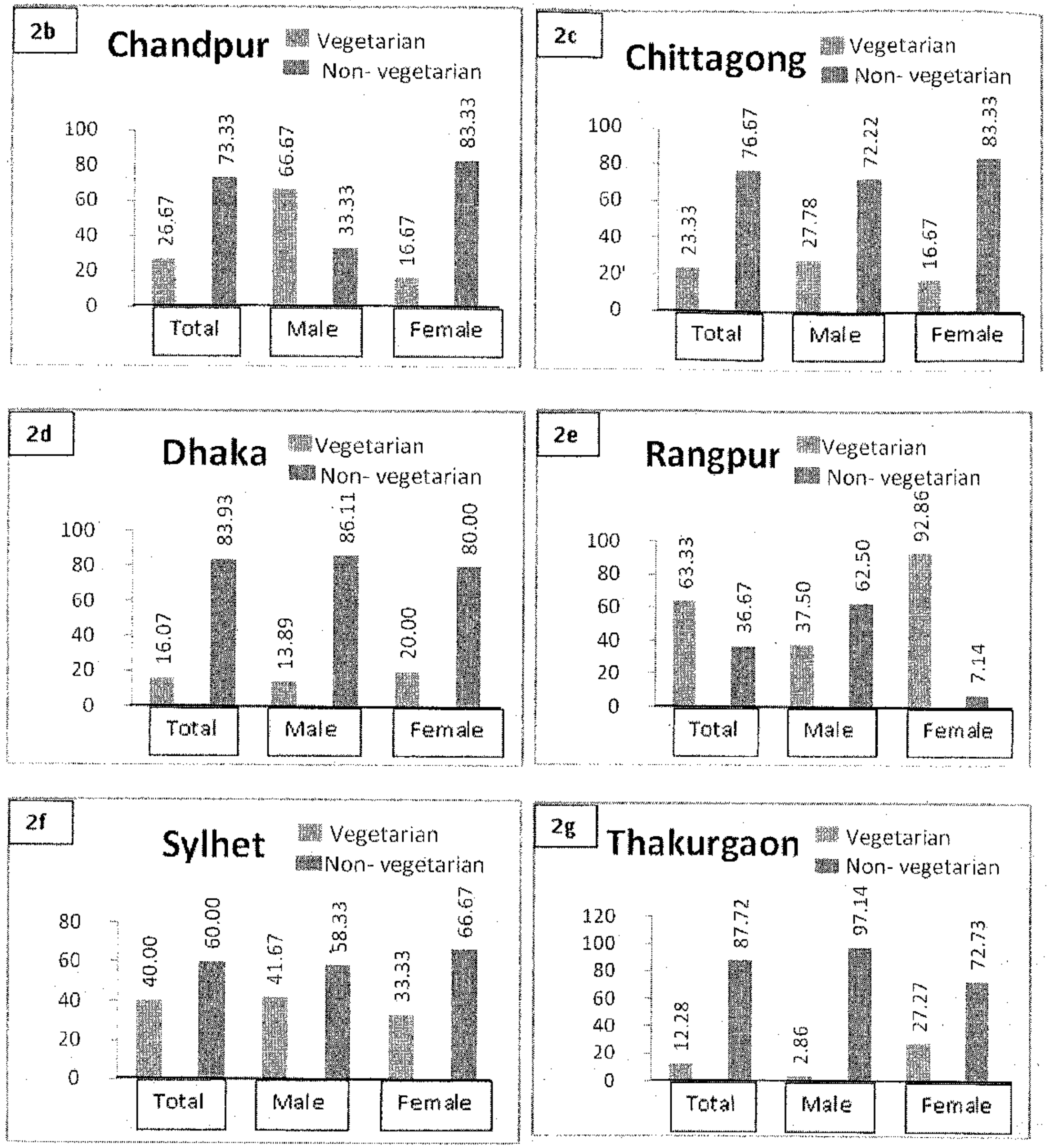


Figure 02: Distribution of Food Choice in Sample Area (a-g)

Among the six areas Rangpur area demonstrates a different situation. In the combined group vegetarians are more than the non-vegetarians ranging from 63.3% to 36.7% (fig 2e) as opposed to 25.6% to 74.4% in the overall distribution (fig 2a). Table-1 shows that the protein production in the form of fish, egg and milk in Rangpur is one of the lowest. Figure 2e demonstrates that the higher distribution in veg food choice in Rangpur area is actually influenced by female group where vegetarian is about 92.8% to only 7.2% non-veg females. The veg food choice in the male group Rangpur area is also higher than other areas ranging to 37.5% to 62.5% in veg to non-veg group. If we compare Chandpur (fig-2b) and Rangpur (fig 2e) we see that male group in Chandpur favour more veg diet whereas in Rangpur it is female group. Table-1 shows that vegetable production in Chandpur region is one of the lowest where as the protein productivity in Rangpur region is lowest as well. Perhaps, lower productions influenced diet and thus the female counterparts serve their male partners more protein. However in the combined group non-veg choice is more that of non-veg in Rangpur as opposed to Chandpur which reasonably supports the productivity nature displayed in table-1.

If we look at figure-1 and the distribution of production in background section we can see that Rangpur is Northern part of the country have less water body, dry in nature therefore do not produce much fish. However, the region produces lots of vegetable (table-1). On the other hand in Chandpur there are plenty of water bodies producing significant amount of fish in the country. It is understandable that high vegetable producing region prefers more vegetable in their diet and such productivity is mainly environmental.

In other three areas, Dhaka, Sylhet and Thakurgaon (Fig 2d, 2f, and 2g respectively) the distribution of veg to non-veg ratio shows that non-veg diet preference is higher than that of veg in all three groups: combined, male and female. However, their dimensions are not same. In Dhaka the differences in ratio of non-veg to veg is higher ranging 16% veg to 84% non-veg because the productivity of the region is high and most people here depends on market availability and affordability for procuring food price. However, Thakurgaon area (fig-2g), though showing the similar trend of Dhaka is due to high productivity and availability. Table-1 shows that the agricultural productivity of Thakurgaon district is high, and the vegetable production is the third highest among all. Wheat production is highest there. The combination of wheat meal might need occasional meat component for taste resulting in more non-vegetarian than veg with veg to Non-veg food ratio of 12.3% to 87.7% for combined group (Fig-2g). Similar is the case for male and female groups of Thakurgaon region.

In Sylhet region the rational differences are less (Fig 2f) having veg to non-veg ration of 40% to 60% in the combined group. The trend is also similar in male group 41.7% to 58.3% and in female group 33% to 67% respectively. Here the trend can also be explained from their regional productivity. Sylhet is very fertile region producing lots of fresh water fish in wet season and high agricultural production during dry season.

The ratios of veg to non-veg reflect the environmental situation of the area.

Conclusions

In summary from the study it is evident that the productivity and market availability of food crops have strong influences on food choices of the people. However, social environment, like dedication of females to male has also influence on food habit of the regions studied in Bangladesh. Therefore, living in harmony with nature productivity is a root metaphor and an imperative required resilience in the post climate change global discourse on environmental crisis. For generation, traditional cultures have lived in harmony and balance with the natural environment. People have managed to survive without compromising the ability to subsequent generations to satisfy their basic needs. Traditional cultures are generally characterized by their respect for and ability to live within the constraints of nature. Though climate change could have significant impact on the food habit of Bangladeshi people are still trying to cope and adapt with this changing environment for their survival.

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BANGLADESH ACADEMY OF AGRICULTURE (BAAG)

ANNUAL REPORT 2012

Since the 17th Annual General Meeting held on April 23, 2011, the activities of the Executive Council were as summarized below:

1. Meetings of the Executive Council

The Executive Council met 7 (seven) times during the period (July 9, 2011; July 23, 2011; .September 26, 2011; and October 27, 2011; November 26, 2011; February 25, 2012 and April 11, 2012).

2. Fund Raising for BAAG

In the last Annual General Meeting held on April 23, 2011, a decision was reached that the matter of fund raising with reference to a letter written by the President to USDA, the matter needed further follow-up. Two distinguished Fellows, Professor Dr. Lutfur Rahman and Dr. A. Q. Shaikh, pursued the matter with the Planning Commission of the Government which referred them to the University Grants Commission (UGC). The UGC felt unable to help in the matter.

3. Award of Supreme Seed Gold Medal of BAAG 2010 and Round Table Discussion 2011

(i) The Gold Medal Award 2010

BAAG's Gold Medal 2010 was awarded on October 2, 2011 to Mr. Md. Asadul Baqui, Principal, Fisheries Training Institute, Chandpur for his remarkable contributions in sex reversed Tilapia production and nets for cage culture in the private sector.

(ii) Round Table Discussion

Dr. M. Anwarul Quader Shaikh, a distinguished Fellow of the Academy, presented an elaborate paper on the topic of the Round Table Discussion, **"Agricultural Research and Extension Management: Achievements and Weaknesses"**. Nearly 70 professionals attended the Round Table Discussion and many of them took part in a lively discussion Krishibid. Dr. M. A. Razzaque MP, Honourable Minister of Food and Disaster Management and Krishibid Shaukat Momen Shahjahan MP, Chairman of the Parliamentary Standing Committee for the Ministry of Agriculture graced the occasion as Chief Guest and Special Guest respectingly . A press release was issued on the Round Table Discussion. The event was televised in BTV and Channel i and was published in more than one daily newspaper.

The salient recommendations that came out of the discussion were:

* Participatory approach to research-extension should be emphasized
* University teaching should be integrated with mainstream research
* The gap between technology demand and technology supply is widening and the research

sector needs to narrow the gap.
* There is increasing dearth of talents in the research system and there is there is only 19% PhDs in the NARS of Bangladesh against 75% in India.
* Research-extension linkage should be strengthened
* Budgetary fund for agriculture research-extension should be increased.
* There should be a greater linkage between different sub-sectors of agriculture
* IPR for agriculture system to be established with seriousness.
* Bangladesh needs crop varieties resistant to salinity, drought and water submergence and BAAG can help formulate policies.
* Marketing, value addition and research in processing needs emphasis
* We need to have separate Bangladesh Science Services for Scientists
* The retirement age of scientists should be increased to 65 years.

(iii) Speech by the Donor of BAAG, Krishibid Mohammad Masum, Chairman, Supreme Seed Company Limited and Distinguished Fellow of BAAG at the Gold Medal Award Ceremony

The Donor of BAAG, Krishibid Mohammad Masum, Chairman, Supreme Seed Company Limited and a Distinguished Fellow of BAAG in his speech at the Gold Medal Award ceremony highlighted the contributions his company had been making in the seed sector of the country, especially in making seeds of hybrid rice and hybrid cotton available to farmers, in addition to seeds of vegetables and seed potato. He also highlighted the challenges the private seed sector had been facing, especially in terms of uneven competition, lack of policy and technology support as compared to the multinational companies. He nevertheless assured that Supreme Seed Company would continue to support BAAG and thanked the Academy for the opportunity given.

4. Donation from Mr. Masum, Chairman, Supreme Seed Co., 2011

The General Secretary being fallen ill with heart complications and hospitalized, the President of the Academy wrote a letter to the donor, Mr. Mohammad Masum of Supreme Seed Co. on November 28, 2011 and the Academy received a cheque of Tk.1,00,000 (Taka One Lac) the same day.

5. BAAG's Office Space in the Concord Buildings

The tenant in the BAAG's Office Space became a long defaulter in payment of rents and did not improve in spite of notices given to him. The Executive Council decided to evacuate the tenant. Although it was a difficult task to evacuate, with persistent efforts by the BAAG officials the space was eventually vacated and has been rented to a different tenant with increased amount of rent.

6. Publication of BAAG Journal Volume 4 Number 1. 2011

The journal was published in December 2011 and copies were distributed.

7. Food Security, Agricultural Technology and Seed Fair, Jessore

At the request of Ullasi Srijoni Sangha and Gaidghat Krishi Prajukti Bastobayan Kendra, Jessore, the Academy organized a Food Security, Agricultural Technology and Seed Fair, at Khajura, Jessore from 9- 11 Match, 2012. The President and the General Secretary along with office staff attended the inaugural session of the fair. The President was given a memorable reception at the fair for his contributions on agricultural research and development in the country. The cost was mostly borne by the NGO, Ullasi Srijoni Sangha and partly by BAAG.

8. Publication of the News of Independence Award 2012 to the President of BAAG

The news of the Independence Award 2012 to the President of BAAG, National Emeritus Scientist Dr. Kazi M. Badruddoza was published in as many as eight newspapers. A reception in his honour by the Academy was organized today May 12, 2012 prior to the Annual General Meeting. Receptions were also organized by several other institutions including the Bangladesh Academy of Sciences (BAS).

9. Election of the BAAG Executive Council 2012

The Election Commissioner, Mr. Enamul Hoque, declared the results of the election held during March and April on April 11, 2012 as follows:

President:	: Dr. Kazi M. Badruddoza (re-elected)
Vice President	: Dr. M. Anwarul Quader Shaikh (elected)
General Secretary	: Dr. M. Gul Hossain (re-elected)
Treasurer	: Mr. M. Enamul Hoque (elected)
Members	: Dr. M. Ameerul Islam (re-elected)
	: Dr. M. Motlubor Rahman (re-elected)
	: Dr. M. Shamsul Alam (re-elected)
	: Dr. M. Golam Ali Fakir (elected)
	: Dr. M. A. Razzaque (re-elected)
	: Dr. M. Shahidul Islam (re-elected)
	: Professor Dr. A. M. M. Tareque (re-elected)
	: Mr. Farid Uddin Ahmed (re-elected)
	: Dr. M. A. Mazid (elected)

Dr. M. Gul Hossain
General Secretary

BANGLADESH AGRICULTURE

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