

Research-Extension Linkage and Policy Development

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**Project Implementation Unit
National Agricultural Technology Program-Phase II Project
Bangladesh Agricultural Research Council
New Airport Road, Farmgate, Dhaka - 1215
Bangladesh**

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Foreword



National Agricultural Technology Program Phase II Project (NATP-2) is a comprehensive project with a focus on revitalizing the agricultural technology system and increasing agricultural productivity in Bangladesh funded by the World Bank, International Fund for Agricultural Development, the United States Agency for International Development and the Government of Bangladesh. Strengthening capacity of the research of the National Agricultural Research system (NARS) is one of the major objectives of the research component.

Since the decade of nineteen seventies after independence of the country (NARS) institutes have developed large number of production technologies to achieve national food sufficiency. However, the flow of handing over technologies from research institutes to extension agencies and finally to the farmers is still sluggish. In some cases it has taken more than a decade for promising and well adopted rice varieties developed by BARI that reduced faster progress to achieve the national demand of food grains. It is imperative that the poor linkage among the NARS institutes and extension agencies resulted wide spread yield gap between research stations and farmer field.

Considering these factors, PIU-BARC, NATP-2 organized a national workshop on the 23 December 2020 on Research Extension Linkage Strategy of NARS and Policy Development in presence of Honorable Agriculture Minister Dr. Muhammad Abdur Razzaque, Mr. Md. Mesbahul Islam, Senior Secretary, Ministry of Agriculture and heads/DGs of NARS institutes including Director General of DAE. Five policy papers presented in the day long workshop by BARI on behalf of the NARS, DAE, DLS, DoF and BAU. These papers illustrated the merits and weaknesses of existing research extension linkage systems and put forward recommendations to strengthen the bonding between concerned research institutes and extension agencies to achieve faster transfer of agricultural technologies to the farming communities.

I appreciate the efforts of the paper presenters of BARI, DAE, DoF, DLS and BAU and their associates for preparing the policy paper of the national workshop on Research-Extension Linkage & Policy Development.

I appreciate the contribution and sincere efforts of scientists of NARS, extension officials of DAE, DoF and DLS, Professors of Universities. I acknowledged the efforts of the Director, PIU-BARC and his team for preparing the proceedings of the national workshop on Research-Extension Linkage & Policy Development and collective efforts to reach the desired objectives of the NATP-2.

Dr. Shaikh Mohammad Bokhtiar
Executive Chairman

Preface



National Agricultural Technology Program-Phase II Project (NATP-2), a national project of the People's Republic of Bangladesh jointly funded by GoB and IDA/IFAD/USAID has been started its interventions through the coordinated efforts of Ministry of Agriculture (Lead Ministry) and Ministry of Fisheries and Livestock to improve national agricultural productivity, market linkage and farm income, with a particular focus on small, marginal and female farmers. The agricultural research component (Enhancing Agricultural Technology Generation) of NATP-2 is being implemented by the Project Implementation Unit (PIU) of BARC in order to generate demand-driven technologies for crops, fisheries and livestock sub-sectors.

Agricultural Research Institutes (ARIs) of National Agricultural Research System (NARS) have served to achieve national food sufficiency though developing the large numbers of new varieties and production technologies. With the increase in population, it is possible to increase food production at a geometric rate with the adoption of new varieties and technologies. Recently government has given thrust to transform subsistence agriculture to commercial agriculture by reducing production costs and post harvest losses as well as strengthening domestic and international market linkages. To fulfill this aim and to achieve SDG Goal-2 we need to reform the research extension linkage policy.

Considering the transforming of agriculture, PIU-BARC organized a national workshop on 23 December 2020 on Research Extension Linkage Strategy of NARS in presence of high officials of Ministry of Agriculture, NARS institutes, BADC, extension agencies of DAE, DoF and DLS. Policy papers presented in the workshop with a key note paper 'Research Extension Linkage Strategy of NARS' by BARI, the largest NARS institute on behalf of the NARS. Research-Extension linkage of Department of Extension (DAE) was presented by representative of DAE. Similarly Research-Extension linkage of Department of Livestock Services (DLS), Research-Extension linkage of Department of Fisheries (DoF) and Research-Extension linkage of Universities were presented by the representatives of the organizations. These papers point out the merits and weaknesses of existing research extension linkages and put forward recommendations to strengthen the bonding between concerned research institutes and extension agencies to achieve faster transfer of agricultural technologies to the farming communities.

I hope this national workshop proceedings will be useful to the policy makers, scientists, extension workers, teachers, students, donor, and other stakeholders for future references.

I acknowledge the contribution and sincere efforts of the scientists of NARS, extension officers of DAE, DoF and DLS, Professors of Universities and personnel of NATP-2 Project to success the national workshop on Research-Extension Linkage and Policy Development and finally create scope to publish the proceeding.

A handwritten signature in black ink, appearing to read 'Dr. Md. Harunur Rashid'.

Dr. Md. Harunur Rashid
 Director

CONTENTS

Sl. no.		Page no.
1.	Citation	i
2.	Foreword	ii
3.	Preface	iii
4.	Research-Extension Linkage Strategy of NARS: Present Status, Strength, Weakness of Technology Transfer and Way Forward for Improving Linkage	01
5.	Research-Extension Linkage Strategy of DAE: Present Status, Strength, Weakness of Technology Transfer and Way Forward for Improving of Linkage	21
6.	Research-Extension Linkage Strategy of DoF: Present Status, Strength, Weakness of Technology Transfer and Way Forward for Improving Linkage	31
7.	Research Extension Linkage Strategy of the Department of Livestock Services (DLS): Present Status, Strength, Weakness of Technology Transfer and Way Forward for Improving the Linkage	41
8.	Research Extension Linkage Strategy of University: present status, strength and weakness of technology transfer and way forward	52
9.	Recommendations on Research-Extension-Linkage and Policy Development	66
10.	Photographs	70

Research-Extension Linkage Strategy of NARS: Present Status, Strength, Weakness of Technology Transfer and Way Forward for Improving Linkage

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Abstract

Attaining sustainable development goals are the top ranking challenges of all the developing countries of the world. In line with the challenges Bangladesh Government has made significant drives and made remarkable progress in achieving self-sufficiency in food grains production. Presently food and nutrition security is one of the most important priority focus of Bangladesh Government. Formulation of dynamic agricultural policy and dissemination of NARS institutes developed agricultural technologies at farmers' field are thought important window for resolving these challenges. Despite wide spread yield gap between research station and farmer's field is a growing concern for agricultural sector. Among others traditional extension approach along with weak and reluctant linkage among the NARS institutes and extension agencies seems to be the major factor for reducing the yield gap at farm level. In addition, the structure and service delivery strength of DLS and DoF is not well equipped at grass-root level for dissemination of livestock and fisheries technologies countrywide. This requires more attention for the development of smarter and economically, environmentally and socially viable agricultural technologies by NARS institutes addressing production, processing, marketing, value addition, climate change etc. and their effective up-scaling mechanisms through strengthening functional linkage with DAE, DLS, DoF are deemed important driving factors. Jointly research program planning, implementation, monitoring and evaluation by NARS scientists and extension personnel may be fruitful for strengthening linkage between NARS institutes and extension agencies. Partnership between Research-Extension-Private sectors can also play an important role in strengthening research-extension systems. Simultaneously, strengthening of On-Farm Research Division (OFRD) of BARI/Out Reach Division of NARS institutes would be a promising platform for researchers and extension providers to work together for technology validation and dissemination at farmers' level. Like NARS, formation of National Agricultural Extension System (NAES) would be helpful for upgrading extension services and delivery of NARS technologies at production and post-production level. Strengthening of Technology Transfer and Monitoring Unit (TTMU) of Bangladesh Agricultural Research Council (BARC) with adequate manpower and logistics will help to strengthening, screening assessing and evaluating of agricultural technologies and dissemination process through coordination among NARS institutes and extension agencies.

Keywords: *Research-extension linkage; agricultural policy; technology transfer; BARC; NARS; extension agency*

1. Introduction

Bangladesh is an agro-based country and its development is largely depends on agricultural development. Eighty percent people of Bangladesh depend directly or indirectly on agriculture. The current share of agriculture to Gross Domestic Product (GDP) is 12.68% and employs about 48% of the working force. Again, crops dominate in sub-sector contributions to GDP having 7.12% followed by Fisheries (3.07%), Livestock (1.79%), and Forestry (1.35%) (Aaron, 2021). The quantum jump in the rice, potato, wheat, jute etc.

production from 10.59, 0.85, 0.11, 0.68 million metric tons, respectively, in 1971 to over 35.3, 11.0, 1.24, 1.54 million tons, respectively, in 2019 is a spectacular achievement in Bangladesh agriculture (BBS, 2018 & BBS, 2019). The outstanding achievement in agricultural production is noted as globally 2nd position in Jute and Jackfruit production; 3rd in rice and vegetables production; 7th in potato and mango production and 8th in guava production. The global ranking is 1st position in exporting of jute. It is noteworthy that technology generation and dissemination is the major contributor of such agricultural advancement. Moreover, research as well as extension and their linkage need to strengthen to achieve the target under SDG goal 2 'by 2030, and double the agricultural productivity and incomes of small scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, through secure and equal access to land, other productivity resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment are important.

Improved agricultural technologies can boost farm productivity to meet the increased demand of food for the people. However, technology generation and technology dissemination can not function in isolation. Transfer of improved technology to farming community is as important as development of technology itself. Although formal agricultural research began in 1906, on-farm research was initiated in 1957 with fertilizer trials to disseminate knowledge and encourage farmers to use fertilizers. On-farm research on wheat was initiated in 1973 to select location-specific suitable varieties. Cropping systems research began in 1974 with trials involving rice and sugarcane-based cropping systems and component technologies. In 1979 a National Coordinated Cropping Systems Research Project was initiated by the Bangladesh Agricultural Research Council (BARC) with the participation of several national agricultural research institutes, Bangladesh Agricultural Research Institute, Bangladesh Jute Research Institute, Bangladesh Agricultural University (BAU) and Bangladesh Water Development Board (BWDB). In 1984, a Farming Systems Workshop summarized research progress and suggested an integrated approach. Consequently, a National Coordinated Farming Systems Research Project was initiated in 1985, which was renamed as National Coordinated Farming Systems Research and Development Program in 1989. In 1997, initiated Agricultural Research Management Project (ARMP) lead by BARC funded by World Bank. A FSRD approach project was implemented across the country with active participation of research, extension and other development partner. A large number of technologies were developed and disseminated to the farmers' level and created a good impact in agricultural production

The present population of Bangladesh is about 164.7 million which will increase to 189.85 million by the year 2030. The estimated food requirement, especially rice and wheat will be 43.6 million metric tons (mmt), fish requirement 5.80 mmt, meat, milk, and egg requirement will stand at 8.30, 17.50 mmt and 19750 million numbers, respectively. There will be a serious gap between demand and supply if the current rate of productivity and production continues. Therefore, the increase in productivity and production rate in all agricultural sub-sectors is of prime importance to meet future demand and, therefore, linkage among research-extension-farmers need to be strengthened to achieve the desired production target.

Climate change are impacting and creating pressure on agricultural land, water and biodiversity which are creating new challenges in agriculture. Considering this in view, BARC recently prepared 12 sub-sectors document on prioritized researchable areas in order to mitigate and overcome the foreseeable problems. The Project Coordination Unit (PCU) of the National Agricultural Technology Project (Phase-I) prepared Vision Document-2030 for Crops, Fisheries, and Livestock Research in Bangladesh keeping in view the national programs, policies, and emerging challenges in agricultural sectors.

Bangladesh agriculture has undergone a metamorphosis since 1957's due to large number of innovative approaches tried for technology development and dissemination. Nonetheless, the sequels of such approaches are substantial in the wake of green revolution. Agricultural research in Bangladesh is the mandate of NARS institutes and Agricultural Universities. There are 13 agricultural research Institutes under five different Ministries which constitutes National Agricultural Research System (NARS). The Institutes within NARS are coordinated by the BARC, established in 1973. About 972 varieties (viz. BARI: 587, BRRI: 106 and BINA: 112 and other NARS institutes) and 1392 agricultural technologies (viz. BARI: 581 and other NARS institutes) released by NARS institutes, among which, few are adopted by the farmers and these might be due to knowledge gap and differences in the management practices of research institutes farm and farmers practices and weak research-extension linkage viz-a-viz improper dissemination techniques.

In order to accelerate the demand-led technology generation and technology transfer, the National Agricultural Technology Project (NATP) was launched with the financial support from the World Bank, and IFAD during 2008-2009 (i) to upgrade and strengthen the research capabilities of the countries research institutions, (ii) to increase the productivity by reducing the technology gaps at farm level and (iii) to meet the needs of extension agencies and farmers through solving location specific problems. It was a major step aimed towards generating location specific technology at the regional level with the involvement of multidisciplinary research team in conjunction with the farmers by conducting need based location specific production and post-production technologies. Albeit some of the generated technologies developed by the research institutes or universities did not satisfy the needs and solutions of the farmers either due to non-suitability of the technology or less thrust given by the extension departments due to fund shortage and knowledge gap of the extension providers. This demands for Research-Extension linkage at all stages of research and technology extension planning process.

2. Strength and weakness of present research- extension linkage systems

Strength

Bangladesh Agricultural Research Institute (BARI), the largest research institute, maintains three layers of review programs (regional, internal and central). Regional Agricultural Research Stations or On-Farm Research Division (OFRD) conduct regional review workshops once in a year to review results of research, regional crop performance and research programs associated with BARI mandated crops which are subsequently placed in the central research review and planning workshop. All scientists of the institute take part in the internal (divisional) review, which takes about 6-8 weeks. The internal review is more rigorous in nature where all research programs and projects are reviewed in detail to improve quality of research programs and experimental design. The external members are also invited in the review workshop. The central workshop reviews the yearly programs where representative of extension departments, universities, and private sector and other organizations, and retired scientists are invited to participate. Usually, the senior scientists present the research programs in the internal and central review workshops.

The present systems of technology development by NARS institutes are two types e.g. generation and introduction. Farmers need based, problem oriented and location specific technologies are developed at on-station, then validated at different locations as regional yield trial and also as on-farm trials. Proven technologies are then packaged with all information/procedures of cultivation and the technology packages are discussed and hand over to extension department through regional and divisional workshop, training,

exchange visit, field day and also through books, booklet, leaflet, fact sheet, etc.

There is scope for the improvement of research-extension linkage. Agricultural Research Institutes (ARIs) usually arranged training/ workshops/seminar etc. to update the current technological knowledge of the extension officers. Some ARIs do not have strong technology dissemination division like OFRD, BARI. During 1980 and 90s some nodal committees made significant progress in strengthening R-E linkage. District Technical Committee (DTC), Regional Technical Committee (RTC) and the National Agricultural Technical Coordination Committee (NATCC) meetings contributed largely in research and extension program development, through participatory discussion among the research and extension personnel of crops, fisheries and livestock departments. The above committees are reformed now with a view to work more efficiently than before. The DTC is now reformed as DATEC (District Agricultural Technology Extension committee), which is chaired by Deputy Director, DAE. The ATC is now reformed as RATEC (Regional Agricultural Technology Extension committee), and is chaired by Additional Director, DAE. The NATCC is now reformed as NATEC (National Agricultural Technology Extension committee) which is chaired by Executive chairman, BARC.

To coordinate the extension activities of NATP, Upazilla Extension Coordination Committee (UECC), District Extension Coordination Committee (DECC) and National Extension Coordination Committees (NECC) were formed drawing personnel from DAE, DoF, DLS, scientists from research organizations, banks, cooperative department etc. These committees are chaired alternately on yearly basis by the DAE, DoF, and DLS at Upazilla, District and at Departmental Level. UECC is chaired alternately by UAO/UFO/ULO. DECC is alternately chaired by Deputy Director Agriculture/District Fisheries Officer/District Livestock Officer. NECC is alternately chaired by the Director General DAE/Director General DoF/Director General DLS. UECC approved the Upazilla Extension plan and DECC endorsed the Upazilla Extension by combining the extension activities of DAE, DoF and DLS of NATP.

The above mentioned committees are well designed but need to make more functional. These committees should discuss on the planning and implementation of extension activities, performance of technology at field level, any emerging issues at field level, feedback from farmers and extension providers. These committees should also discuss coordination among the departments. They should also plan for joint planning and implementation of validation trials. They should also visit each other's program and joint monitoring at field level. They should publish proceedings of the meeting to share with research and extension departments. But these are not happening on regular basis. Provision of meeting cost may help to hold the meeting regularly. Top level monitoring is also important to make these committee effective. Engagement of senior extension personnel from DAE, DLS, DoF etc. will make more fruitful outcome of the committee.

Technology Transfer and Monitoring Unit (TTMU) of BARC was established in 1989 to facilitate research-extension linkage and monitoring of technology performance at field level. It should also take the lead role in coordinating technology transfer across all disciplines of agriculture and should provide technical, financial and managerial support related to the activity. The unit should also play a role in interfacing research and extension personnel. The responsibility of TTMU also includes screening and assessing the generated technology for packaging. Recently they are assessing and packaging the technology in collaboration with ARIs modestly. The unit could not function as expected because of their inadequate manpower and logistic facilities. TTMU needs to be made more functional with adequate human resources. TTMU has developed a model for transferring of profitable technology of NARS institutes in Bangladesh (Fig. 1).

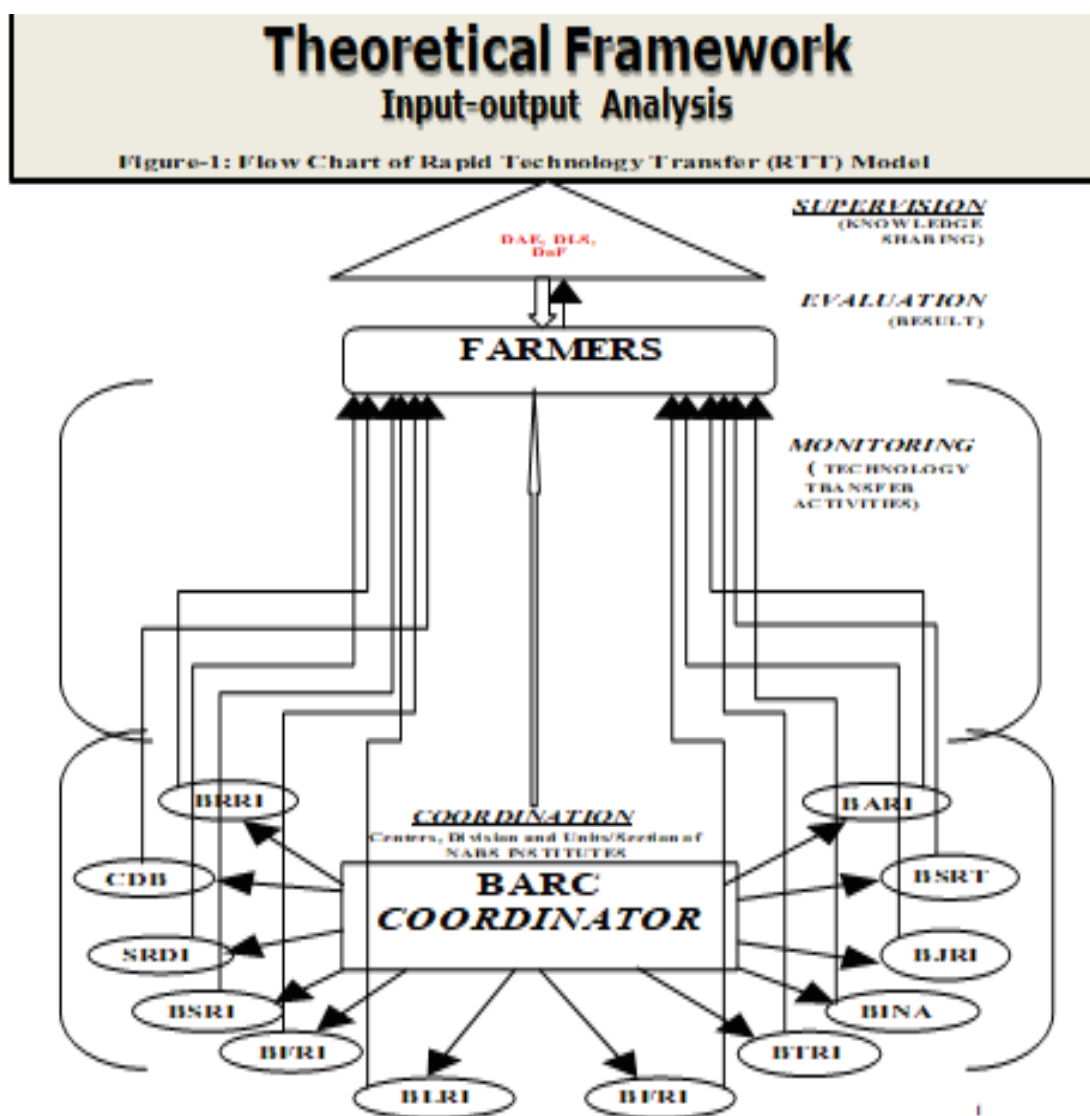


Fig.1: Rapid Technology Transfer Model (RTT)

KGF was funded by NATP-1 until 2014 December. After December 2014 KGF started using the endowment fund for contract/commissioning research. Competitive Grant Program (CGP) was implemented through the participation of NARS institutes, public universities, private/NGOs etc.

The limited effectiveness of the Training and Visit (T&V) system, of technology transfer which was initiated during 1978-79, was reformed for greater participation of farmers, private sectors in technology transfer activities (World Bank, 2003). The new extension strategy includes: (i) decentralization of authority from the center to the districts and upazillas within the Department of Agricultural Extension (DAE); (ii) the use of groups rather than contact farmers (CFs) in communications with farming communities; (iii) greater efforts to assess farmers' needs and tailor messages to their priorities for a wider range of commodities and subjects; (iv) strengthening linkages with public and private organizations concerned with research, inputs and marketing as well as extension; and (v) a sharper focus on poor and disadvantaged groups, including women (DAE, 1999). These reforms are to be pursued concurrently with efforts to reduce costs towards more profits.

Research institutes and agricultural universities may have the strength to undertake agricultural development work on a limited scale to provide direct transfer of information by educating extension workers and farmers regarding the advantages and potential of new technology developed (Fig. 1). This could be done in various ways-

- Technology Demonstrations on farmers' fields
- Implementing Pilot project
- Site selection for operational/on-farm research project
- Jointly implementing of 'Minikit' trials
- Working with local extension workers
- Sensitizing Subject-matter specialists
- Formulate packages of improved farming practices
- Advice to visiting farmers or through correspondence
- Training to farmer and extension officers
- Preparation of technology hand book (Publication)
- Preparation and supply of simple audiovisual aids/documentary
- Interaction at Information centre with extension agents
- Organization of exhibitions and farmers' fairs
- Organization of workshops, seminars and symposia for farmers and extension workers
- Technology/policy brief through print and electronic media (Television, radio and the press)
- Visitors as source of information communication and feedback etc.

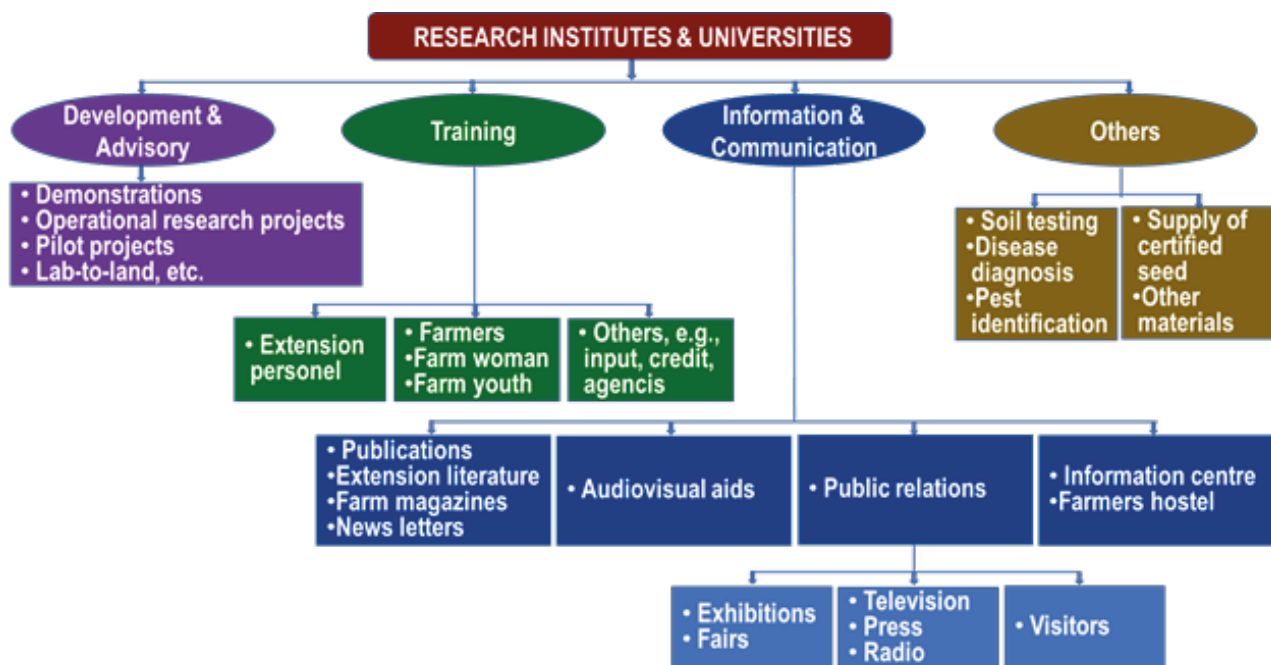


Fig. 2: Role of research institutes and agricultural universities in transferring technology

Weakness

There are some weaknesses prevailed in the present research extension linkage systems, some of them are listed below-

(a) Institutional:

- Inter - institutional linkage among NARS institutions is inadequate and is not coordinated strongly.
- Research-extension partnership project is very limited.
- Number of Research and Extension office is not sufficient.
- Issue of Newly developed variety -Seed multiplication-Extension-Marketing linkage is not well addressed.
- Absence of common platform for technology generation and dissemination involving multidisciplinary stakeholders.

(b) Program implementation:

- Technology transfer experience sharing workshop is not arranged with field level extension officers at the end of each cropping season or half yearly basis.
- Mid-term evaluation workshop of extension activities is absent at national level.
- Research-extension planning and coordination meetings are not arranged periodically before the cropping seasons
- Less engagement of researcher and extension personnel in joint program planning and technology transfer activities.
- Training and Field Days are organized and implemented without the involvement of researchers and extension providers especially in the program organized by DAE.
- Insufficient and or weak feedback of researchable problems provided by DAE hamper research program planning.
- Normally, farmers' field is not visited jointly by researcher-extension officers- field level officers of BADC and personnel of marketing department.

(c) Procedural and or lack of clarity in coordination and management:

- Working experience of both Research and Extension with farmers are not shared with each other even in summarized form.
- Limited participation of researcher in field day and training program of DAE, DoF and DLS organized event.
- Absence of total package of farming practices support to farmers for production in agricultural development activities.

(d) Knowledge, capacity and skills:

- Often scientific suggestions/ criticisms are not duly taken care-off or reflected in research planning workshop for improvement of the research program.
- Exchange visit is very limited for both Researcher and Extension officers for sharing their views on field activities.
- COVID-19 situation is limiting the common technology transfer methods like training, workshop, exchange visit etc.

(e) Policy:

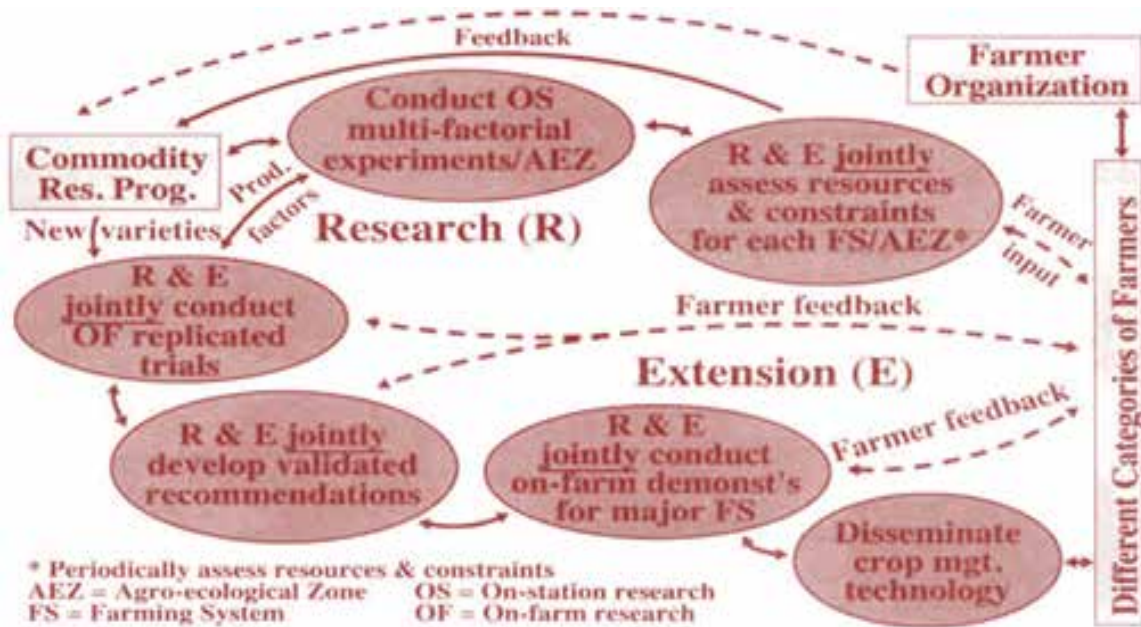
- Participation of Extension officers in research review workshop must be made compulsory to improve feed-back system from extension for research and development planning. Their participation is not regular at present.
- All researcher should work at research- station level and at field level in association with extension personnel but practically this is absent.
- Digital information transfer and feedback could be introduced though it is not easy and costless.
- Facilities are not equal for all remote areas for both researcher and extension officers.

(f) Human resources:

- The Technology Transfer and Monitoring Unit (TTMU) of BARC is constrained with inadequate officers/ staff and logistic facilities to play effective role in research-extension linkage and coordination activities.

3. Gaps and Missing Links of Research-Extension linkage

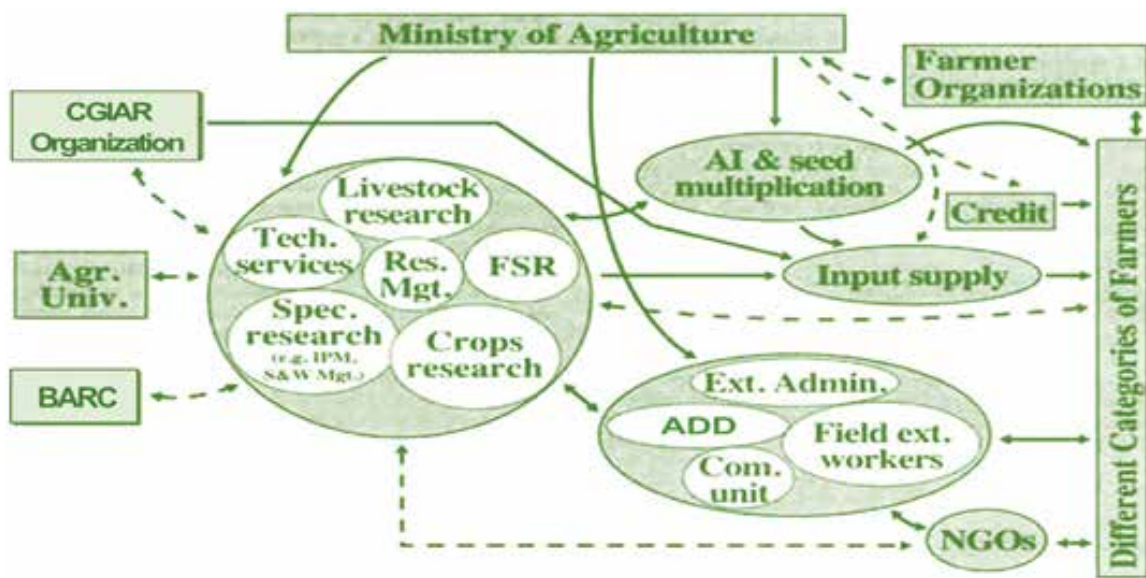
- Commodity technologies especially genetic (improved varieties or hybrids) technologies are getting higher priority over non-commodity technologies like- Crop management practices, Plant protection (e.g., IPM), Cropping systems, Farming systems, Soil and water management practices, Farm mechanization, Agroforestry, Post-harvest technology, Farm management etc. in technology transfer system/program.
- Full package of technology are not demonstrated at farm level in many cases that results less impact in the adoption of whole package of technology by the farmers. Component technology can be demonstrated to those farmers who has already adopted the full package of technology that requires some replacement or addition with new component technology.
- Regional suitability and their proper management practices for the region are not considered like time/ management/fertilizer dose, variety developed for non-stressed area used in stressed area and vice versa.
- A wide extension service gap is the result of non-delivery of full information from extension personnel to farmers and farmer's feedback to extension agents that hinders farmers' decision to accept or reject technology.
- Inadequate seed supply of newly released varieties and propagules of fruit varieties made it difficult for the extension providers for faster dissemination of newly released varieties.
- Linkage of technology recipient client group and research systems is weak because the recommended farming practices, (except variety) sometimes are not matching with the farmers' resource base, family needs and market demand. Further, the research effort does not address their immediate and pressing problems.
- Less involvement of researchers in trainers training and farmers training organized by extension departments.
- There are some problems in linkage as identified are: The institutional components that typically make up an Agricultural Technology Systems (ATS) have some gaps. As described by Swanson (1993), Figure 3 portrays the major institutional components that are found within most national ATSs, including a representation of some linkages used to help integrate this macro technology system. In this diagram, research and extension are divided into their respective sub-units and operate within the policy direction and support of the ministry of agriculture. But most of the cases it is not happening.



Source: <http://www.fao.org/3/w5830e01.htm>

Fig. 3: Institutional components of an agricultural technology system

Figure 4 depicts a poorly linked research and extension (R&E) system, where the commodity research team does not collaborate directly with extensions (Additional Deputy Director-ADD) in planning, conducting, and interpreting data from agronomic trials. Also, these researchers do not interact with farmers or their organizations in the process of identifying production problems, setting research priorities, or in carrying out these trials. Furthermore, in this case, researchers do not discuss research findings with ADD in the process of developing farmer recommendations; rather, they send a research report to extension that summarizes their findings. At this point, it is up to the ADD to interpret these findings and formulate a package of recommendations for dissemination to farmers. However, most ADD lack sufficient analytical skills, including the ability to use economic criteria, in formulating technical recommendations.



Source: <http://www.fao.org/3/w5830e01.htm>

Fig. 4: Poorly linked research and extension system

Figure 5 reflects a more fully integrated research and extension system for developing crop management technology for a specific commodity. The process begins with a joint assessment of farmer resources, constraints, and priorities. This needs assessment process could be carried out through a rapid or participatory rural appraisal. Then, at each step in the process of developing technical recommendations, there is a close working relationship between researchers, ADDs, and farmers, until research findings are finally tested and demonstrated on farmers' fields.



Source: <http://www.fao.org/3/w5830e01.htm>

Fig. 5: Linked research-extension-farmer system for crop management technology

- There is gap in salary of women labor.
- Shortage of quality seeds are major hindrance against dissemination. The BADC is not interested to produce an improved variety seed before demand is created at farmers' level. In addition most of the private seed companies/agencies are interested in seed import rather than production of seeds locally. However, some private companies have already started variety development and seed production, marketing and their transfer program locally.
- Less availability of spare parts of different agricultural machines/devices/tools, skilled manpower to operate, repair and maintenance service at rural level and no alternate use of a machine during off-season are the major hindrance in the expansion of farm mechanization.
- Less investment capacity of farmers for high value and high investment technology
- Join validation trials by researchers and extension providers before recommendation for extension is inadequate.

- Lack of initiatives for identifying farmer's innovative technology and back to Researcher through Extension.
- Absence of Research-Extension linkage desk both in research and extension departments.
- Weak intra and inter-research institute linkage and agricultural universities with NARS institutes.
- Weak front line technology transfer capacity of NARS institutes with extension departments.

4. The present policy in research, extension and farmer linkage

Agricultural research and extension services in Bangladesh got initial momentum during the green revolution campaign which was modestly started in mid 1960s. The green revolution further accelerated after 1971 with the cultivation of HYV wheat and rice in 1974. Since then the systems is evolving and several transformation occurred. The training and visit system (T & V) of extension service was introduced in 1977 with few districts and covered all over Bangladesh in 1982. The T&V system was however, revised and missing elements such as group approach, decentralization, responsive to farmer's needs, involving women in extension and participatory extension were incorporated in extension service. The ASSP set the stage to adopt a new Agricultural extension policy in 1996. The gradual reform in extension services from communication centered to capacity building through education and training provides more focus on development of empowerment and human quality. With the help of new knowledge and paradigms shift the agriculture sector is playing crucial role in economic development and alleviation of hunger and poverty in the country (NAP, 2018). However, growing demands for food and other necessities require agriculture sector to deliver further by substantial production boosts through intensification, diversification and facilitating agri-business in the country. A formal, well organized institutional mechanism for coordinating the Education-Research-Extension (ERE) functions is essential to meet the diverse needs of farmers in crop, fisheries and livestock sub-sector.

Research-Extension-Education Linkage

1. Effective linkages of the Research, Extension and Education organizations is to be formulated by the apex body, BARC for enhancing technology generation, validation and transfer. Kristi Vigan Kendra popularly known as KVK (Agricultural Science Center) in ICAR, India approach may be reviewed for possible adoption.
2. Each NARS institutes should have a technology transfer wing having provision for requisite number of personnel for monitoring and evaluating extension activities. National and local level nodal points comprising research and extension service providers be established and linked for efficient agricultural technology system.
3. Collaborative research programs involving NARS institution and public universities could be undertaken as a large number of highly qualified scientists are engaged in universities. BARC as an apex body is to be worked with UGC/competent authority.

National Agricultural Extension Policy (NAEP)-2012

The New Agricultural Extension Policy (1996) has been updated as National Agricultural Extension Policy (2012) addressing the key constraints, emerging issues and strategic shifts of agriculture sector in the context of present national and global scenario to maintain food security of rapidly growing population.

The NAEP was built on nine (9) key principles:

- Enhance production (horizontal and vertical) and productivity ;
- Cost effective, efficient, decentralized and demand responsive extension services;
- Targeting and mobilizing farmers group (FG) and their federations (FO);
- Bottom-up planning and implementation;
- Coordinated and integrated extension services through NAES;
- Development of agri-business and contract farming for export promotion;
- Adaptation to climate change and development of specialized extension service for climatically distressed areas;
- Broad based extension support (in-time input support and subsidies, credit, price enhancement etc.); and
- Digitalized agricultural extension services (e-agriculture)

National Agricultural Extension Policy (NAEP)-2020

The National Agricultural Extension Policy 2020 has been in place and aimed at achieving demand-led research and extension services for the farmers. This demands strong research- extension linkage at policy and operational level. The main goal of this policy is to ensure the production of climate smart, environment-friendly, safe, sustainable, nutritious and profitable crops through delivering demand-based technology and modern information technology services to the farmers and entrepreneurs of all classes.

NAEP in fact emphasizes on participatory extension approach where all stakeholders define their vision, analyses constraints, needs and plan together for implementation, monitoring and evaluation. It also recognizes multifactor, multi-approach and multi-method that are effective and complement each other. It also focuses on demand driven and market oriented extension. The strategy recognizes complementarities and potential synergies of different actors in agricultural development- farmer’s organizations, research, extension, agricultural education institutions, input supply, credit and other private and public partners intervening the sectors.

To achieve the above goal in relation to different agriculture related policies of Bangladesh, the NAEP includes the following key strategic functions.

1. Development of extension work plan based on the suitability of different Agro-ecological zones.
2. Farmer and agriculture entrepreneur based extension services
3. Commercialization of agriculture
4. Recognition of farmer/farmers group/agricultural entrepreneur as a partner of development
5. Capacity development of production organization for agricultural products value add management
6. Development of sustainable farmers group/organization
7. Address integrated farming systems
8. Establishment of extension workers cooperation service systems
9. Strengthen E-agriculture programs

10. Emphasis on the adaptation of technology with climate change
11. Social safety net
12. Specialized extension services
13. Ensure quality of the products
14. Use of weather data and information for crop production and management
15. Increase revenue budget for agricultural extension program
16. Strengthen coordination of Research-Extension linkage*
17. Strengthen coordination of public-private organizations
18. Strengthen coordination with international agriculture organizations
19. Emphasis on the use of agriculture inputs support card
20. Sustainable soil health management
21. Protect agriculture land for the use of non-agriculture activities
22. Encourage of export oriented agriculture and discourage of import agricultural products
23. Use of geo-special data base, GIS and remote sensing technology
24. Strengthening of environment friendly agriculture systems
25. Agricultural mechanization
26. Limited use of underground water for agriculture activities
27. Strengthening of nutrition safety
28. Strengthening of backward and forward linkage for agriculture industries
29. Agriculture loan
30. Use of local government fund for agriculture sectors
31. Strengthening of agroforestry and social forestry program
32. Strengthening of agriculture tourism
33. Branding of agricultural products
34. Development of skill and capacity
35. Provide service through establishment of Agriculture clinic, Rural Technology centre (RTC) and agriculture business centre
36. Our village our town
37. Reorganization, synchronization and coordination
38. Increase quality and excellence agriculture services
39. Coordination of agriculture extension policy implementation, monitoring and research

* To make Extension service more effective, R-E linkage is vital. The communication and coordination between research and extension should be strengthened at national, regional, district and upazilla level. To enhance linkage, different committees should be upgraded for more functional. To strengthen R-E linkage, responsibility and accountability should be ensured.

5. Sustainable research extension linkage

Today, the growing demands for food and other necessities require the agriculture sector to deliver further by enhancing productivity and market linkage. The agricultural technology system is getting more complex, knowledge-intensive and demanding under changing environment. Lack of coordination among the actors involved in research extension system is highlighted in most of the policy documents of the government. Corona pandemic and Climate change extreme are impacting the production and post-production system. Considering this, it is high time to accelerate the dissemination process of farm solutions, thus reducing the time lag and quick application of technological interventions through the participation of all actors. A formal, well-organized institutional mechanism for coordinating the research-extension functions is essential to meeting the diverse needs of crop, fisheries and livestock sub-sectors.

Research and extension organizations should step up greater participation at different levels for achieving sustainable linkage. Singh et al., 2019 stated in terms of sustainable linkage as-

1. Production Linkages:

Maintaining regular flow of technological information from its source (NARS institutes) to the client system through Government and Non-government agencies including input supply and services.

2. Technology Generation Linkages:

Developing new technologies to meet the emerging problems faces by the client systems as well as contingency measures to manage pest outbreaks and natural calamities.

3. Post Production Linkages:

Detail the products and services to suit the consumer preferences by assessing the demand of local and export market. Linkages with storage, transportation, packaging, agro-industries helps for value addition. Linkages with various commodity interest groups to identify the bottlenecks and get the feedback to improve the efficiency at all levels.

6. Some important considerations for sustainable research-extension linkage

• FSRD and MLT sites of NARS institutes: Hub of Technology generation and dissemination

On-Farm Research Division of BARI has about 28 research management units, 12 FSRD sites and 85 MLT sites across the country. In addition, other NARS institutes have their limited own outlet for technology dissemination. Joint participation of research and extension personnel in program planning, implementation, monitoring and dissemination process may result in smart research-extension linkage.

• Formation of viable farmers' organizations and linkage with research and extension organization

About 70% of the rural population is directly involved with farming, but there are only a few viable farmers' organizations in Bangladesh. A strong and active farmers' organization can play a significant role in managing market economy and providing feedback for agricultural research and extension services in Bangladesh. The formation of viable farmers' cooperatives or strengthening of the existing cooperatives is highly essential for Bangladesh. The farmers associated with farmers- group/cooperatives can have their voice in addressing farm related problems and can strengthen their market linkage in a group. Their savings can help them during crisis as loan for income generating and farming activities. Some of the important activities that need to be considered for Research-Extension linkage are:

- *Appropriate extension approach need to be developed based on the learning of extension agencies, on-farm research experience with farmers by researchers, NGOs experience and agro-industry working experience with farmers and entrepreneurs.*
- *On-Farm Research could be conducted through farmers group taking into consideration of production and marketing aspects of farmers group.*
- *Development of linkage with Agro industries for industry related technology demand and dissemination for mutual benefit*
- *Development of functional public-private partnership viable for technology generation and dissemination*
- *Involvement of more NGO's in technology extension and diffusion process*
- *Use of ICT for effective communication among NARS institutes, extension agencies and NGO's*

7. Partnership in extension (Private sector, NGO and Public sector research and extension)

Not only the public extension system, but the energies of the private and corporate bodies and non-government organizations involved in agriculture related activities needs to be harnessed. A public-private- NGO partnership is called for-how this may be fostered to the benefit of all needs to be investigated thoroughly and immediately (Karim et al., 2009).

The developed technologies of NARS institutes are disseminated mainly through extension departments but private sectors also playing a significant role especially in input supply sectors. Recently private sectors are also investing in R and D especially in variety development and seed sectors besides of BADC, seeds of different crops varieties are also multiplying and marketing by different private companies through MoU with the respective institutes. Different prototypes of farm machineries are made available to different private workshop for multiplying and sell to the end user with reduced price.

Strengthening “Public-Private-Partnership (PPP)” in Agricultural Extension: For high-value, market led, export oriented sub sectors and producers private sector driven development need to be promoted in: (i) commercial production, processing and marketing; (ii) agro-technology extension services; (iii) market information system (development, expansion and flow); and (iv) establishment and management of agricultural product collection centers, wholesale market etc. The registration and regulations of private establishments in the agriculture sector requires to be simplified for encouraging the development of private sector in seed production, processing and marketing, non-urea fertilizer production and marketing, irrigation equipment’s manufacturing and marketing, mini and small SME in village level. There is also an urgent need to adjust education and training to the needs of the private sector and provide working conditions in line with what is necessary for growth and increased employment and income in agriculture, livestock and fisheries (Nataraju et al., 2001). The leaders of the private sector, on their part, must focus more on productive investment, growth and employment. In accordance with the definition used by the Government of Bangladesh, the following categorization of enterprises: (i) Microenterprise—one to 9 employees, (ii) Small enterprises—10 to 49 employees, (iii) Medium enterprises—50-99 employees and (iv) Large enterprises—100 or more employees, out of which (i) and (ii) will be considered in agriculture sector. The policy development and legal aspects in agriculture sector will be the responsibility of the public sector, where as the private sector will play the role of implementer of the policy framework (NAEP, 2012).

Framework portraying public, private, and NGO partnerships

Afrad *et al.*, 2019 shared details of the partnership in agricultural extension in Bangladesh. The main focus of a public agricultural extension system is on human resource development with a target on capacity building of medium and small farmers so that they may solve their problems and respond to new opportunities. On the other hand, the approach of private agricultural extension service concentrates its resources and expertise on those educational and technical programs wherein it can facilitate the technology transfer to their contract farmers on commercial basis. The NGOs are involved in the development of human and social capital wherein small, marginal, and women farmers get special attention.

On the other hand, the private sector's strengths include an extensive network of regional employees who have direct knowledge of what farmers want for increasing productivity. Public private extension partnerships should leverage the strengths of both sectors to develop timely, relevant, and practical extension programs and materials. Swanson and Samy (2002) suggested a framework for public, private, and NGO partnership which could adequately serve in countries like Bangladesh. The framework suggests that the public institutions should conduct extension programs on postharvest handling and storage, food safety, farm management, and marketing which will help increase farm incomes through intensification and diversification of the farming systems. Moreover, in the absence of NGOs, the public extension could be more instrumental in assisting small-scale farmers to organize into farmers' associations. Several cooperative organizations such as producer associations have proven to be effective in helping small farmers for taking advantage of new market opportunities and by coordinating farmers' input and marketing needs to create economies of scale.

8. Way to improve and strengthen research and extension for effective delivery of technology and services

Strengthening research-extension linkage results in better outcome for effective delivery of technology and services in the rural agro-based community of Bangladesh. Taking some actionable measures in different tiers of research and extension agency may be more effective, relevant, sustainable and scalable. Singh *et al.*, 2015 outlined comprehensive mechanisms for research and extension agencies. Since research and extension personnel have complementary roles in agricultural development, the success of each group is determined largely by the effectiveness of linkage activities. Therefore, appropriate mechanisms to strengthen linkages need to be developed. For developing such mechanisms it is important to understand the principles that determine the success of linkage activities. Mainly six principles of linkage have been identified (Zuidema, 1988):

- Sharing of a common purpose.
- Linkage activities should be compatible with the activities of each group.
- Research-Extension personnel should perceive that it is advantageous for them to participate in linkage activities.
- It should have common ground or proximity of location to facilitate collaboration.
- Rewards of participating in linkage activities should be settled during work plan development.
- Communication between members of different groups should be effective and there should be free flow of information between groups.

The Managerial Mechanisms are:

- Establishing joint reviews of research and extension activities.
- Redefining job descriptions to strengthen relationships.
- Improving individual incentives for collaboration.
- Changing evaluation procedures.
- Exchanging personnel.
- Joint training for elaborate roles in a technology system.
- Joint use of facilities and services.
- Joint participation in technology demonstrations.
- Promoting informal linkages.
- Exchanging information using jointly developed protocols.
- Jointly organize community based synchronize cultivation for greater adoption of technologies.
- Validate promising technologies jointly prior to large-scale dissemination

Ways to improve research-extension linkage

Regular funding for research and extension

Long term research and extension planning, budgeting and mutual commitments with partners requires regular GoB funding rather project based assistance.

Increasing connectivity with Agro-retailers/Dealers

Farmers in the community are more connected with Agro-retailers/Dealers for agricultural inputs (seeds, fertilizers, pesticides etc.) and advices. So providing specialized training by the research and extension agency with location specific technologies and extension messages to Agro-retailers/Dealers become potential actors for effective delivery of technology and services to the farmers.

Continuous education and training for research and extension staff

Provide continuous education to researchers and extension officer's/agents and other incentives, such as operational funds for transport, communication and farmer events, and also on ICT training.

Organizing agro-tours at home and abroad

Production and display of video

Production of videos by different research and extension agencies and displaying them in tea stalls, Union Service Offices, FIAC, NGOs and community-based organizations, agro-retailers would be very much helpful for technology dissemination. Content for videos should be prepared jointly by research and extension people. Videos should be produced locally and validated before mass production. Videos should be used both to train the trainers as well as directly with farmers. Separate viewing groups should be set up for women in the afternoon and men in the evening.

Market engagement

Research and extension should develop plan jointly from input supply-production-marketing. They will fix responsibility of various activities to be performed in different stages of their joint plan. Researchers and extension personnel actually carry out collaborative program activities together, such as on-farm trials and demonstrations, plus joint decision making on technical recommendations and in market linkage activities. In the process of carrying out these different program activities, researchers and their extension counterparts share the responsibility for different tasks and regularly consult with each other on an informal basis. In short, through collaborative program activities, research and extension personnel develop a positive professional relationship that is important, if not essential, in facilitating the flow of technology and feedback information within an Agriculture Technology and marketing systems.

In addition to these formal linkage mechanisms, both research and extension personnel would be expected to have regular, informal contacts with different groups of farmers in their respective service area.

9. Recommendation and way forward

The agricultural research and extension systems in Bangladesh are functioning mostly under separate administrative and management entity. Strengthening research and extension linkage aiming at boosting agricultural production, productivity and net farm income requires these institutions to function in a coordinated and complementary way. The following areas are advocated as way forward to achieve the goal:

- Research agenda and priority should be identified and set for resolving specific problems based on extension feedback with participation of NARS researchers and extension personnel
- Planning, implementing, monitoring of applied research should be done jointly by NARS institutes researchers and extension agencies
- BARC can play a catalyst through NATCC meeting in research-extension linkage. It can create enabling environment and close working relations between research and extension; review, assess and recommend scalable technologies developed by research institutes; support, monitor and evaluate the impact of extension services and on-farm research results; review, co-ordinate and guide different committees formed for research extension linkage purpose.
- Development of vibrant extension approaches with active participation of DAE, NARS institutes and relevant NGO's for effective delivery of technologies and services to different stakeholders.
- Formation of committee for the determination of technology requirement and dissemination process at different tiers in research and extension organizations.
- On-farm research and development at FSRD and MLT sites of BARI and NARS institutes should be considered as a hub of technology validation and dissemination platform with active participation of research and extension personnel
- Development of public-private partnership with engagement of researchers and extension providers for diffusion of agricultural technologies, entrepreneurship development and marketing
- Encourage formation of viable farmers' organizations and connectivity with research and extension organization for effective delivery of technologies, access to market linkage, value addition/chain and feedback

- Regular funding for research and extension from GoB fund rather than project based support
- Continuous education and training for research and extension personnel and field staff
- Agro-retailers/Dealers should be trained to make them technically smarter for product selling with relevant technical advice.
- Provision of incentives for members of research- extension committees formed at different tiers along with meeting cost.
- Location specific viable technologies generated by NARS institutes should be disseminated through large scale pilot production approach with synchronized cultivation instead of mini results demonstration to create greater impact at farm level
- Farmer's group formation and their active participation in large scale pilot production approach should be made to enhance quick diffusion of NARS technologies through more availability of seeds and other materials at field level. This approach will open scope for adoption of different agricultural machineries, encourage entrepreneurship development, facilitate value chain and build farmers confidence on technology adoption.
- Arrange joint crop/season/location/demand specific delivery services
- Implementation of 'Amar Bari Amar Khamar' program jointly by strengthening linkage with Research and Extension personnel at grass root level.
- Participatory technology generation and participatory implementation, monitoring and evaluation of research and extension activities should be used to enhance the research extension farmer linkage.
- Development of village Seed Bank in FSRD and MLT sites of BARI and NARS institutes will lead to faster availability of newly released technologies from research institutes.

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Research-Extension Linkage Strategy of DAE: Present Status, Strength, Weakness of Technology Transfer and Way Forward for Improving Linkage

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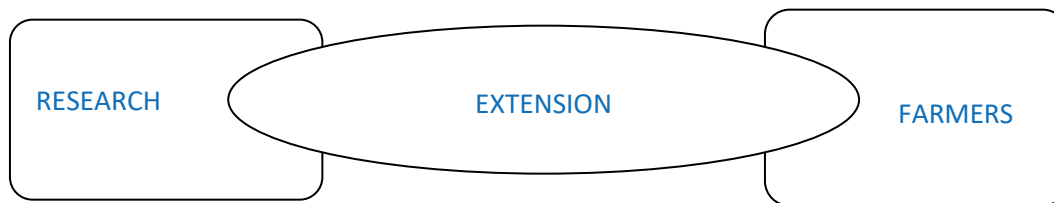
Abstract

Effective research-extension linkage plays an important role in technology generation and dissemination to the end users (farmers). The linkage encompasses a broad range of collaborations and exchange of useful information among all actors of the technology generation, dissemination and utilization system. Agricultural research and extension are examples of two systems that are to be linked through information flow and feedback. The farmers fall in between research and extension (R & E). They are the main targets and beneficiaries of the activities of R & E. The research-extension-farmer relationship is viewed as an inter-dependent and inter-related continuum. A close bonding among the three key players (researchers, extension functionaries and farmers) promotes development of relevant technologies. The adoption of such technologies provides directly measurable results or perceived benefits to the target population. In most of the cases, research and extension linkage systems of agricultural technology development and transfer have tended to be largely based on a ‘top-down’ one-way communication model with information flowing from researchers to end users. In this respect, farmers are considered as passive recipients of research results based on perceived needs identified by scientists. This model also views farmers, extension officials and researchers as three separate strata and the links among them are weak. The ‘top-down’ model of technology development and transfer has led to a situation where farmers have limited options in making decisions on technologies appropriate to their specific farming needs and within their local social, cultural, economic, and political environment. The weak linkage between research and extension is reported as the major factor limiting the flow of information, knowledge, useful new technologies and resources among actors in the technology-delivery-utilization system. It is observed that bridging the gap between research and extension is the most serious institutional problem in developing research and extension programs. So, it is necessary to emphasize that the whole process of technology development and dissemination must be based on equal partnership among researchers, extension agents and farmers who learn from each other and contribute their knowledge and skills. Public-Private Partnership (PPP) needs to be strengthened for the research and technology transfer activities.

Keywords: Research, extension, farmer, linkage, public-private partnership (PPP)

1. Introduction

The ultimate goal of research is to develop technology for the benefit of people. Agricultural technology is a complex blend of materials, processes and knowledge. Because of the complexity of agricultural technology, different institutional arrangements are needed to disseminate different types of technologies to users. Agricultural Extension can be illustrated as the link between research and farmers.



Extension linkage with research and farmers

It is useful to visualize extension as achieving the ultimate economic impact by providing information and educational or training services to include the following sequences:

- i. Farmer awareness
- ii. Farmer knowledge, through testing and experimenting
- iii. Farmer adoption of technology or practices
- iv. Changes in farmers' productivity

The vision of the Department of Agricultural Extension (DAE) in Bangladesh is the 'Sustainable and Profitable Crop Production'. To achieve this vision, it is needed to ensure sustainable and profitable crop production, optimize the knowledge and skills of farmers of all tiers through providing skilled, effective, decentralized, localized, need-based and integrated agricultural extension services.

Agricultural extension assists farmers to make efficient productive and sustainable use of their land and other resources. It is an educational process by which information /advice is generated, shared and used for decision making for farm/farm household's livelihood development. The Agricultural Support Services Project (ASSP), Agricultural Services Innovation and Reform Project (ASIRP) and National Agricultural Technology Program (NATP) funded by the Government of Bangladesh (GoB) and different international agencies have been supporting the strengthening of extension services in Bangladesh since 1992.

In the context of Bangladesh, agricultural extension is a service or system which assists farm people, through educational procedures, to improve farming methods and techniques, increase production efficiency and income, better levels of living, and increasing the social and educational standards of rural life. According to Maunder (1972), agricultural extension is the assistance to farmers enabling them to identify and analyze their production problems, and to increase their awareness of the opportunities for improvements.

In 1996, GoB recognized the multitude of Extension Service Providers (ESPs) in the country, and established 11 principles by which the extension system should operate. These principles were enshrined in the National Agricultural Extension Policy (NAEP), which sought to improve the effectiveness of extension services, particularly for the disadvantaged women and smaller farmers being the priority. The NAEP was largely developed with the recognition that the public sector in particular needed to improve efficiency, effectiveness and targeting. The NAEP principles are:

- Extension to all categories of farmers;
- Efficient extension services;
- Decentralization;
- Demand led extension services;

- Working with groups of all kinds;
- Strengthened research-extension links;
- Training of extension personnel;
- Use of appropriate extension methodology;
- Integrated extension support;
- Co-ordinated extension activities;
- Integrated environmental support.

The NAEP is fundamentally concerned with increased performance. This was particularly in the light of the understanding that significant public and international development funds were being absorbed by ESPs.

The Ministry of Agriculture (MoA) has set its future focus on (a) sustainable food security (b) shifting from subsistence to commercial agriculture (c) modernization and mechanization of agricultural practices (c) crop zoning, and (e) implementation of southern master plan. The "Revised Extension Approaches" can ensure a very effective extension service. The approach consists of five principles: (i) Decentralization (ii) Targeting (iii) Responsiveness to farmers` needs (iv) Use of a range of extension methods, and (v) Working with farmer groups or organizations.

Following all relevant government agricultural policies and approaches, there should have a strong research and extension linkage with the participation of farmers for ensuring food and nutrition security of the people of Bangladesh.

2. Present Status of Research-Extension Linkage of DAE

Development of linkage among Research, Extension and Farmers is undeniable in extension work. Special emphasis has been laid on this linkage in the national agricultural extension policy and the revised extension approach. Research-Extension is working with mutual collaboration and linkage. Connecting the farmer with the research-extension will strengthen the foundation of interconnected bridges. The areas of research-extension-farmer linkage are mentioned below:

According to Agricultural Extension Manual, 2016

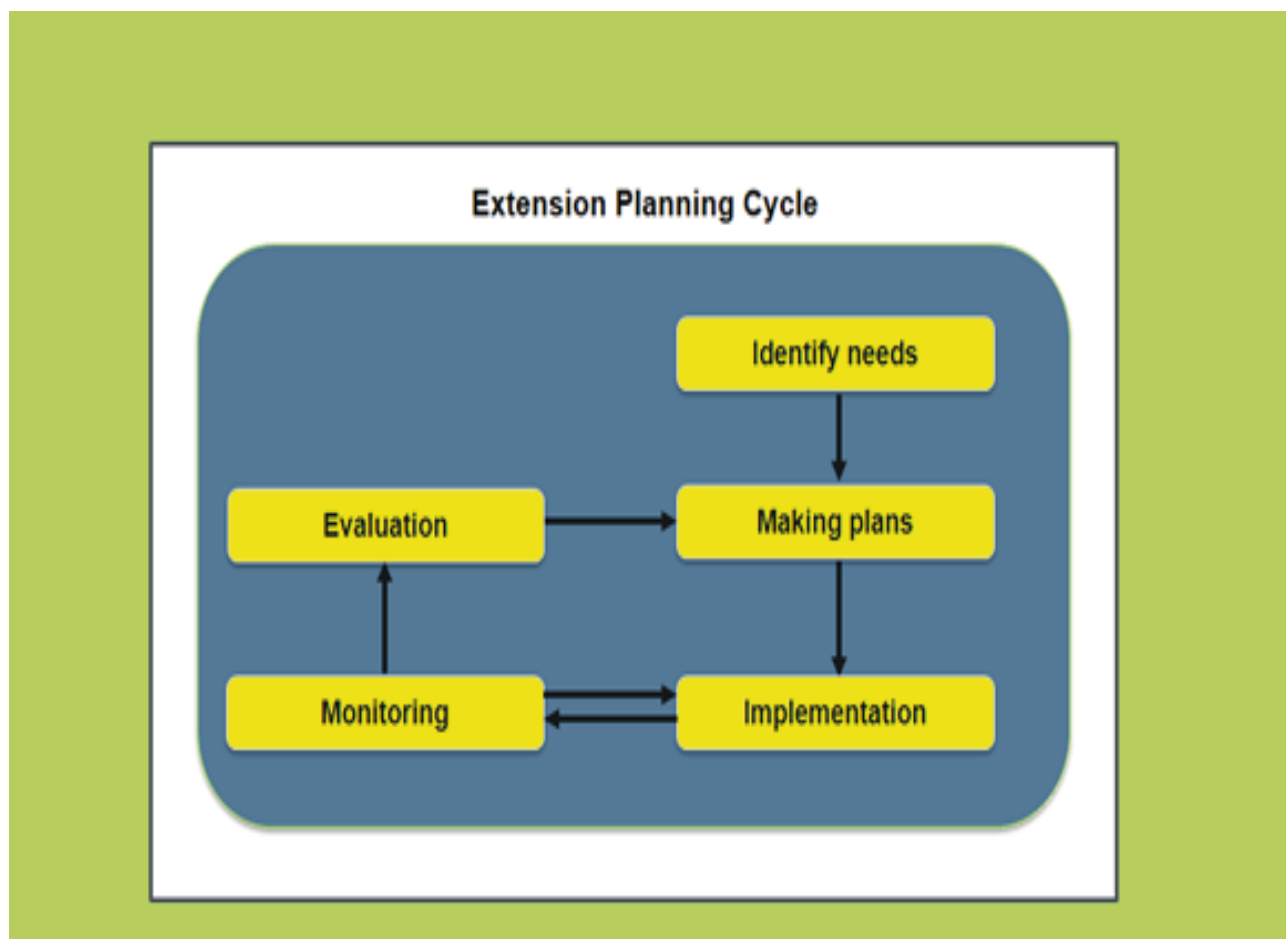
- Extension, research and farmers play an active role in some committees, such as Extension Policy Implementation Coordination Committee (EPICC), National Agricultural Technical Coordination Committee (NATCC), Agricultural Technical Committee (ATC), District Extension Planning Committee (DEPC), Upazila Agricultural Extension Coordination Committee (UAECC) as part of the implementation strategy of the National Agricultural Extension Policy, which are currently reorganized as National Extension Technical Coordination Committee (NETCC), Regional Technical Coordination Committee (RTCC), District Technical Coordination Committee (DTCC), and Upazila Technical Coordination Committee (UTCC) are at the national, regional, district and upazila levels.
- Extension, research and farmers are active participants in the Research Institute Coordination Committee (RICC), Research Institute Planning Meeting, Extension-Research Workshop, Extension Planning Workshop, etc.
- Besides, new areas of extension-research-farmer links need to be identified

According to New Agricultural Extension Policy (NAEP), 2016

The development of close co-operation between extension agencies and formal research institutes is essential if farmers are to be provided with the services they require. Research institutes require information from extension about the problems farmers are facing, for which there are no available solutions, in order to conduct research programs both on- stations and on-farm with farmers. Extension requires the findings from research programs to provide farmers with the most appropriate advice. Effective mechanism to ensure that a free flow of information between extension and research is institutionalized. The main institutional mechanisms are:

- A National Technical Co-ordination Committee (NTCC) , comprising extension representatives from the government, non-government organization and private sectors, and representatives from research;
- Agricultural Technical Committees, each covering a number of districts in similar agro-ecological zones and comprising local representatives of extension agencies and research institutes;
- Research-extension review workshops between staff of the DAE and local research institutes.

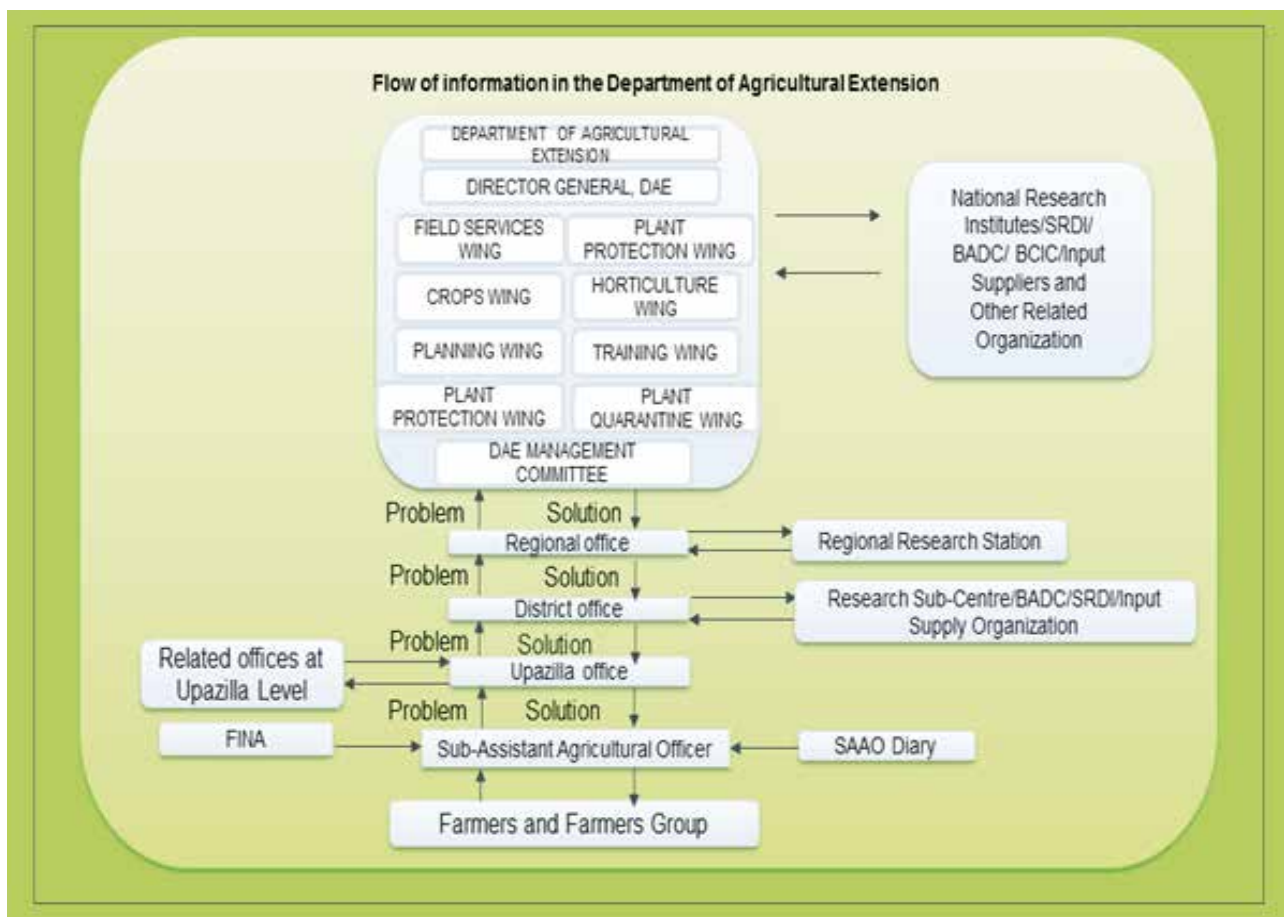
A contract research system enables extension agencies to help develop and fund specific research programs with specific research institutes. The NAEP recognizes that farmers themselves are actively engaged in their own experimentation, as part of their daily agricultural lives. Efforts to learn from and strengthen such informal research are important.



The implementation strategy of NAEP establishes:

- Clear definitions of the roles for the various extension agencies;
- Effective mechanisms for collaboration and information exchange among extension agencies and among farmers;
- Effective mechanisms for the supply, management, and monitoring of resources to support the activities of extension agencies;
- Mechanisms to provide extension agents at all levels with the skills and training appropriate to their job requirements;
- Effective linkage for three-way information flow between farmers, extension agents and research institute staff.

While the NAEP has set the principles for the effective functioning of the National Agricultural Extension System, the Implementation Strategy sets the mechanisms by which these principles are put in place.



According to National Agricultural Policy (NAP)-2018

The National Agricultural Policy (NAP) -2018 emphasizes the importance of Public-Private Partnership (PPP) in the production, storage and marketing of the agricultural produces at the national, regional, district,

upazila and union levels. The policy encompasses the participation of National Agricultural Research System (NARS) institutes, universities, extension agencies, private organizations and NGOs in the adaptive research and dissemination of technologies. The policy also encourages the participation of farmers and local representatives in appropriate crop variety selection and their applied research.

According to National Agricultural Extension Policy (NAEP)-2020

To achieve the target and goal of National Agricultural Extension Policy (NAEP) -2020 all the opportunities of agricultural sectors are taken into consideration and the use of all technology is applied to strengthen the agriculture services (ultimate target of NAEP, 2020). For the implementation, examination and the evaluation of NAEP-2020, short term, mid term and long term planning approaches are under this policy.

Besides all above mentioned committees, Agricultural Technology Extension Coordination Committee (ATECC) is also working for development of research-extension linkage. The Executive Chairman, BARC is the Chair and Director (Field Service), DAE is the Member Secretary of ATECC. This committee plays a major role to develop the linkage among different research institutes and DAE.

Some Project Activities to Develop Research-Extension Linkage

According to the project introduction leaflet of National Agricultural Technology Program- Phase II Project (NATP- II), PIU-DAE, there are national, district, upazilla and union level committees, such as National Extension Coordination Committee (NECC), District Extension Coordination Committee (DECC), Upazilla Extension Coordination Committee (UECC), Union Extension Facility Team (UEFT), etc.. These committees are responsible to coordinate, develop and strengthen the linkage among research, extension and farmers to disseminate the technologies in the field level.

Apart from above, in DAE some other projects like Transfer of Technology for Agricultural Production under Blue Gold Program (DAE Component), Smallholder Agricultural Competitive Project (SACP) and some other projects have a bit contribution to develop the Research-Extension linkage to disseminate new technology from the research stations to farmers' fields.

3. Strength and Weakness of Present Research-Extension Linkage System

Strength:

- i. Attempts are now taken by investigating into the existing structural linkage mechanisms developed by the concerned organization/department to combine research, extension and farmers;
- ii. A number of committees such as NETCC, RTCC, DECC, UECC in the national, regional, district and upazila levels, respectively, are acting to strengthen this linkage;
- iii. Good numbers of parameters/indicators of functional linkages are usually taken in order to come out with better understanding of the linkage;
- iv. Effective linkage for three-way information flow among farmers, extension agents and research institute staff;
- v. Participation of research and extension personnel during technology demonstration;

- vi. Organization of workshops, seminars, field days, exposure visits, etc, with the participation of all relevant stakeholders;
- vii. Existence of group/community-based extension systems;
- viii. Ensuring e-agriculture for effective use of modern agricultural technologies and
- ix. Strengthening crop diversification and crop intensification.

Weakness:

- i. There are inadequate inter-communications and information exchanges between research and extension personnel;
- ii. Research-extension co-ordination committees are mainly formed with project assistance for strengthening the relationship among crops, livestock and fisheries extension persons which may not be sustainable after the end of the project;
- iii. Timely transfer of technology is not possible;
- iv. The technology transfer time (generation to end users) is more than many other countries;
- v. Efficient expansion system is not possible due to lack of desired coordination in the research-extension-farmer linkage;
- vi. The co-ordination committee meetings are not held regularly due to fund crisis;
- vii. Inadequate research institutes in all regions/districts;
- viii. The ‘top-down’ approach of information flows from researchers to end users;
- ix. Lack of strong Public-Private Partnership in technology development and dissemination; and
- x. Lack of participation of farmers and local representatives in the identification of research problems.



4. Gap and Missing Links of Research-Extension Linkage

- a. Gap in agricultural research for promoting export oriented products through coordination with local and international partner organizations;
- b. Missing link to modernize agricultural research, education, extension, input management and develop skilled manpower for sustainable technology innovation;
- c. Lack of coordination between the planning, monitoring and evaluation of agricultural research of NARS; and
- d. Duplication of research.

5. Present Policies Relevant to Research-Extension-Farmer Linkage

Agricultural Extension Manual, 2016

- a. Extension, research and farmers to implement on-farm research and multi-location testing with the cooperation of each other;
- b. Extension and farmers to be included in the training or workshop on "inventive technology reporting" organized by research institutions;
- c. Spontaneous participation of research institutions and farmers in any meeting or workshop or agricultural fair or field day etc. organized by DAE, similarly extension and farmer's participation in the programs organized by the research institutes;
- d. The department of extension implements the motivational tour program for farmers' motivation in the research centers;
- e. DAE and Research work jointly to resolve field level issues;
- f. Research-extension-farmer jointly visits the disease prone areas or hotspots of disease and takes necessary action; and
- g. Extension and research encourage farmers in innovative work.

6. Sustainability of Research -Extension Linkage

- a. Strengthening coordination among the planning, monitoring and evaluation of agricultural research of NARS;
- b. Avoiding duplication of research by establishing 'National Research Data-base';
- c. Taking initiative to provide incentives to intellectual researchers and taking steps to preserve intellectual property rights;
- d. Taking initiative for establishment of a research center in places of important agricultural environment for the development of suitable regional agricultural technology;
- e. Initiating the Advanced Research Methods in the NARS Institutions and Universities and investing in research to take the highest social benefits and value addition from research;
- f. Communications among researchers, extension agents and farmers are to be strengthened, and
- g. Necessary allocation to be provided from the revenue fund instead of project fund for holding the meetings of coordination committees regularly.

7. Partnership in Extension (Private Sector, NGO and Public Sector Research and Extension)

- a. DAE is to maintain connectivity and coordination with Agricultural Information Service (AIS), BADC, BCIC, Bank and all the public or private or semi-autonomous or autonomous private organizations. This will increase mutual partnership;
- b. An effective National Technical Co-ordination Committee, comprising extension representatives from the government, non-government organization and private sectors, and representatives from research;
- c. Agricultural Technical Committees, each covering a number of districts in similar agro-ecological zones and comprising local representatives of extension agencies, private sector, NGO, public sector and research institutes;
- d. Research-extension review workshops between staff of the DAE and local research institutes with private sector, NGO and public sector;
- e. Effective linkage for three-way information flow among farmers, extension agents and research institute staff and
- f. A contract research system to be set up to enable extension agencies to help develop and fund specific research programs with specific research institutes.

8. Way to Improve and Strengthen Research and Extension for Effective Delivery of Technology and Services

- a. The selection of research problems should have demand-driven and 'Bottom-Up' approaches instead of only top-down process;
- b. Strengthen extension services through local/regional/ national level agricultural technology expansion consisting of research and extension organizations;
- c. Take steps for updating and implementing extension activities by replacing the poor performed varieties with new ones according to the decision of the technology expansion coordination committee;
- d. Develop an evaluation system in the exhibition set up for expansion of technology, by including participation of all stakeholders and considering consumer demand and other matters;
- e. Strengthen agricultural research and extension relations and enabling and implementing knowledge of each other through participation in all activities related to workshops, meetings, monitoring, etc.;
- f. Ensure of sustainable technology through the development of research-extension-farming relations;
- g. Ensure of uninterrupted expansion of technology by establishing block transfer of agricultural technology;
- h. Develop new areas of community/community-based extension services and take measures for their implemented;
- i. The local extension workers will play the role of primary sources in providing information and advice;
- j. Ensure the expansion of e-agriculture for the holistic use of modern information and communication technology; and use of mass media to spread the technology; and
- k. Farmer's interests will be given 'priority' to make the extension services fruitful, 'Lab to Land', 'Science to Society', 'Information Friend/Technological Agent' and other innovative expansion strategies to be adopted to strengthen extension.

1. Ensure promoting private entrepreneurs (seed, fertilizer, irrigation etc.) to engage in research and extension services

9. Recommendation from DAE

- The factors affecting the strength of linkage are required to be objectively identified and delineated in future researches.
- Ensure uninterrupted expansion of technology by developing new area of community/community-based extension services and take measures for their implementation;
- More numbers of actors of development as input supplier, financial institutions, rural institutions and other informal sources of knowledge and information as traditional wisdom, farmer-farmer linkage and alike should be included in future investigations;
- Encourage the work of NARS organizations intensively with the works of the International Agricultural Research Institutes/Centers;
- Enhance government initiatives to increase regional co-operation in the activities of innovation and technology;
- Strengthen the participation of domestic institutions in international research and emphasize the inclusion of local priority issues in international collaborative research; and
- Take initiatives in the field of innovation/dissemination of technologies and sharing of experience at international / regional levels.

10. Way Forward

- Attempts should be made to quantify the strength of functional linkage among researchers, extension personnel and farmers. This objectivity will be greatly useful to the development administrators, extension management and policy makers to design the linkage strategy as effectively as possible;
- Coordination by BARC to the implementation and monitoring of research supported by international agencies;
- Encourage initiatives taken by developed/developing countries and international/regional organizations for the development of plant resources and exchange of modern knowledge and skills.

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Research-Extension Linkage Strategy of DoF: Present Status, Strength, Weakness of Technology Transfer and Way Forward for Improving Linkage

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Abstract

The fisheries sector plays a significant role in food and nutritional security, employment and economic growth. An effective linkage among research, extension and farmers is the prerequisite for the effective transfer of modern technologies to the farmers, which is necessary for sustainable development. Department of Fisheries (DoF) and Bangladesh Fisheries Research Institute (BFRI) are the two public organizations principally responsible for technology dissemination and research, respectively. Some of the public Universities also research for the new technology generation. But, a formal research-extension linkage policy or strategy is absent at present. Only an annual research review workshop arranged by BFRI and occasional seminars, workshops and meetings facilitate informal linkage between research and extension. DoF performs its technology dissemination activities through the revenue and development (project-based) set up with limited human resources and logistics having no extension workers at the Union level. However, some of the NATP-2 project-based initiatives, such as UECC, DECC and NECC meetings; regional research-extension linkage workshops; partnership building between BFRI and DoF through pure line brood program, the establishment of FIAC, etc. were found effective for research-extension linkage. A successful effective linkage among research, extension and NGOs was found in Hilsa fishery management. This paper has made some specific recommendations and a way forward with an immediate focus on the formulation of a research-extension linkage policy, strategy and action plan to institutionalize the linkage system. It is also suggested to strengthening the capacity of DoF and BFRI, prioritizing research areas, mainstreaming different project-based activities including demonstration among others for the sustainable development of the fisheries sector in Bangladesh.

Keywords: *Research, extension, linkage, DoF, BFRI, technology, fish-farmers.*

1. Introduction

The fisheries sector has been significantly contributing over the past few decades in meeting the nutritional needs of our population, creating employment opportunities, alleviating poverty and earning foreign currency. This sector contributes 3.50 percent of the country's GDP and more than a quarter (25.72 percent) of the agricultural GDP (2018-19) (DoF, 2020). About 20 million people (12 percent) of the country are making a livelihood by directly or indirectly engaging in various activities in the fisheries sector. Bangladesh produced 43.84 lakh metric ton fish in 2018-19, which recognized as a world-leading fish-producing country. According to the FAO report The State of World Fisheries and Aquaculture 2020, Bangladesh ranked 3rd in inland open water capture production, 5th in world aquaculture production, 4th in tilapia production (FAO, 2020). The country has enormous potential to export fish and fishery products that help earn foreign currency. Although aquaculture has tremendous progress for the last couple of decades, there is enormous scope to increase the present level of aquaculture production through improved aquaculture and management technologies. Expansion of modern technology is correlated to strong research-extension linkage.

The extension is a process of communication between researchers and farmers through extension workers. This is a two-way channel in which modern technology developed in research organization/University, is disseminated to the farmers through extension organization and farmer's problems/feedback goes to the

researchers through extension workers (Fig. 1). So, extension acts as a bridge between research and production. Fisheries extension plays a crucial role in boosting fisheries productivity, improving rural livelihoods and promoting fisheries as an engine of pro-poor economic growth.

An effective linkage among the researchers, extension workers and clients are the prerequisite for the development of the fisheries sector, particularly in the area of aquaculture, open water fisheries management, marine and brackish water fisheries, and value-added product development. Farmer's needs should be identified properly and considered in designing the research agenda. Similarly, farmers' feedback on demonstrated technology in the field should be considered for fine-tuning of the technology. The success of agricultural research as a catalyst to any nation's development depends largely on how well researchers and extension personnel communicate and cooperate each other (Cernea et. al., 1985).

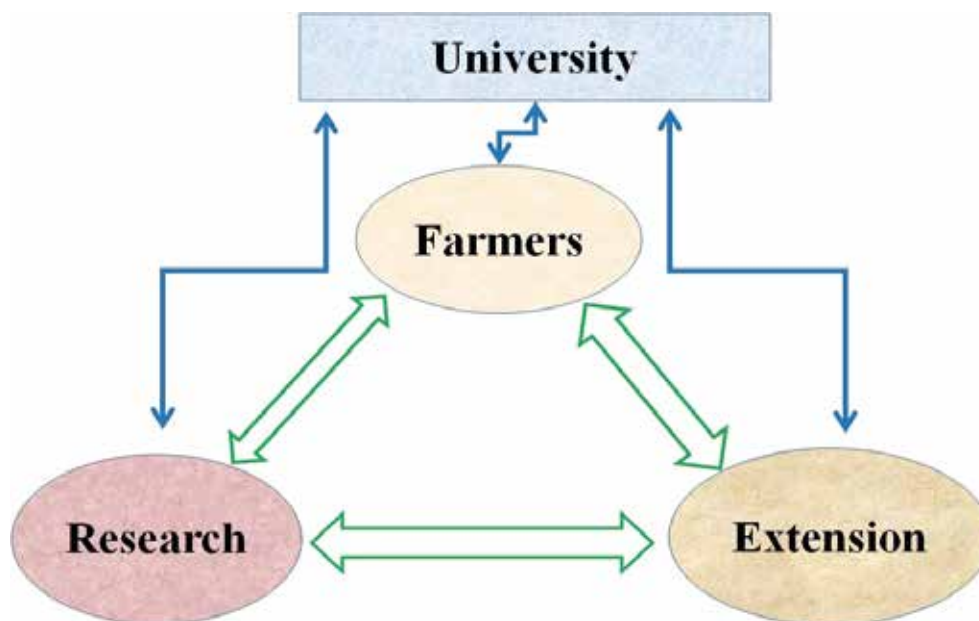


Fig. 1. A schematic diagram showing research extension linkage.

2. Present state of research extension linkage

2.1. Agriculture Research System in Bangladesh

The National Agricultural Research System (NARS) of Bangladesh consists of thirteen (13) research institutes under the umbrella of the Bangladesh Agricultural Research Council (BARC). Out of the thirteen research institutes, eight belongs to the Ministry of Agriculture (MoA), two to the Ministry of Fisheries and Livestock (MoFL), one to the Ministry of Commerce, one to the Ministry of Jute and Textile, and one to the Forest and Environment Ministry. In addition, the NARS also comprises universities, NGOs and the private sector that have a casual working relationship with BARC and other related organizations. The thirteen research institutes under the NARS are:

- i. Bangladesh Rice Research Institute (BRRI)
- ii. Bangladesh Agricultural Research Institute (BARI)
- iii. Bangladesh Jute Research Institute (BJRI)
- iv. Bangladesh Institute of Nuclear Agriculture (BINA)

- v. Bangladesh Livestock Research Institute (BLRI)
- vi. Bangladesh Fisheries Research Institute (BFRI)
- vii. Bangladesh Sugarcrop Research Institute (BSRI)
- viii. Bangladesh Tea Research Institute (BTRI)
- ix. Bangladesh Forest Research Institute (BFRI)
- x. Soil Resources Development Institute (SRDI)
- xi. Bangladesh Sericulture Research and Training Institute (BSRTI)
- xii. Cotton Development Board (CDB)
- xiii. Bangladesh Wheat and Maize Research Institute (BWMRI)

The Bangladesh Agricultural Research Council (BARC) is the apex body of the NARS. The Council serves as the national coordinating organization for planning, integration, and implementation of research on crops, soil, water, crop protection, agricultural engineering, livestock, forestry, fisheries, economics and social science. BARC also identifies problem areas in agriculture and prepares national plans for agricultural research within the framework of national policies and development goals. The Council collaborates with the international and national research centers to ensure a rapid introduction, evaluation and use of improved agricultural technologies. BARC is responsible for planning, developing and upgrading of human resource development base of the NARS.

The research institutes have their separate acts/laws/ordinances and mandates. They are governed by their separate management boards. The role of the institutes is defined by their respective acts/laws/ordinances. They are responsible for the task of generating technologies in their respective fields of activity. All the research institutes have their network of regional stations, centers and sub-stations throughout the country. These stations do research on a regional and local basis to cover different agro-ecological zones of the country. BFRI is the only institute of NARS that researches in fisheries.

2.2. Bangladesh Fisheries Research Institute

Bangladesh Fisheries Research Institute (BFRI) is the only autonomous government research institute for fisheries and related research under the MoFL. The institution was founded in 1984 and started functioning in 1986. It carries out basic and applied research based on the sector demand and innovates appropriate technology for the development of the fisheries sector. The technology innovated by the institute is being disseminated to the field by DoF. The institute manages 5 research stations located at Mymensingh, Chandpur, Paikgacha (Khulna), Cox's Bazar and Bagerhat and 5 sub-stations located at Rangamati, Santahar, Patuakhali (Khepupara), Jashore and Sayedpur.

2.3. Fisheries related University

Higher education, as well as research activities in fisheries, made a breakthrough advancement in 1967 with the establishment of the Faculty of Fisheries in Bangladesh Agricultural University (BAU). Later, many other public universities have been established to gear up higher education and research in the fisheries sector. They provide graduation, masters, as well as some of them, offer Ph.D. programs in fisheries. The Universities are as follows:

- i. Bangladesh Agricultural University,
- ii. Khulna University
- iii. Rajshahi University
- iv. Hajee Mohammad Danesh Science and Technology University

- v. Dhaka University
- vi. Patuakhali Science and Technology University
- vii. Bangabandhu Sheikh Mujibur Rahman Agricultural University
- viii. Sylhet Agricultural University
- ix. Jashore Science and Technology University
- x. Chattogram Veterinary and Animal Science University
- xi. Noakhali Science and Technology University
- xii. Sher-e-Bangla Agricultural University
- xiii. Bangamata Sheikh Fojilatunnesa Mujib Science and Technology University
- xiv. Institute of Marine Sciences and Fisheries, Chattogram University
- xv. Khulna Agricultural University

The Universities also conduct basic and applied research in fisheries. But the research results and innovated technologies are rarely available for transfer at the farm level. Therefore, a strategy needs to be developed to bring the research outputs to the field level.

2.4. Fisheries Extension Services in Bangladesh

Department of Fisheries (DoF) is the apex organization to implement and coordinate all the fisheries extension activities being carried out in the country. Since the late forties, the DoF has been continuing as a front-line public sector organization for fisheries development. After the independence of Bangladesh in 1971, the Central Fisheries Department of the then Pakistan was merged with the DoF of Bangladesh in April 1975. Later on, in 1984 Central Marine Fisheries Department was merged with the DoF as a Marine Fisheries wing.

DoF is under the administrative control of the MoFL. DoF has technical officers and staff at different stairs to render their services to achieve the mission and vision of the organization. It has administrative set-ups at division, district and Upazila (sub-district) levels headed by Deputy Director (DD), District Fisheries Officer (DFO) and Senior/Upazila Fisheries Officer, respectively. Besides, there are three fish inspection and quality control stations under DoF. Furthermore, DoF also comprises Marine Fisheries Station, Fisheries Training Academy, Fisheries Training and Extension Centers and Fish Hatcheries.

Because of the growth potential of aquaculture, in recent years, due attention has been given to support this sector with a focus on pond aquaculture. However, DoF focuses extension work on pond, open water, marine and brackish water fisheries, quality control and value-added product development aspect as well. It provides extension work through the revenue (permanent) set up as well as development (temporary) set up. The revenue set up consists of 8 Divisional DDs, 64 DFOs and 487 Senior Upazila/Upazila Fisheries Officers. It has only five members in the Upazila level including one Senior Upazila/Upazila Fisheries Officer, one Assistant Fisheries Officer, one Field Assistant and two support staff under revenue budget. Unfortunately, DoF has no staff at the Union level. Its all services are Upazila centered, from where the DoF's staff performs all fishery-related activities, such as extension, training, advocacy, conservation and law enforcement. DoF also engaged some Local Extension Agents for Fisheries (LEAF) at the Union level through projects like the National Agricultural Technology Project (NATP) and Extension of Aquaculture Technology up to the Union Level Project.

Besides, the Fisheries and Livestock Information Office (FLIO) is established in 1986 under the MoFL. It has four branches in Dhaka, Rajshahi, Barishal and Cumilla. They also extend technological information using

printing and electronic tools, such as leaflets, booklet, posters, documentaries, TVC, TV fillers, etc. A monthly bulletin is also published from FLIO which extends many update news, technology and information about fisheries and livestock development activities.

Apart from the public organizations, fisheries extension services are also provided by different NGOs, private feed companies, chemical and drug companies/dealers, private hatcheries, etc.

2.5. Existing Linkage

Although there is no formal research extension linkage policy/strategy in the fisheries sector, DoF and BFRI are the two public institutions working together for the development of this sector, while BFRI is responsible for research and DoF is responsible for the extension. Experts from the DoF, BFRI, Universities and NGOs develop research ideas and agree on priorities through discussion in workshops, and then the selected research topics are sent to the MoFL for approval and execution. BFRI arranges an annual research review workshop in this regard at the national level in Dhaka in which researchers, DoF officials, especially from Head Quarter (HQ), NGOs and farmers participate. Besides, BFRI arranges regional progress review workshops in Mymensingh, Chandpur, Cox's Bazar, Paikgacha (Khulna) and Bagerhat annually for the same purpose where researchers, DoF officers from different regions, NGOs and farmers participate. The main task of conducting applied and adaptive research has been bestowed upon the BFRI although Universities are also involved. The BARC is the national body for coordinating, monitoring and evaluating all agricultural research. Also, international organizations such as CIRDAP, FAO, DFID, Danida, World Bank, CIDA, IDRC and WorldFish Center are involved in action-oriented research programs related to fisheries in Bangladesh. The technologies innovated by BFRI are disseminated by the DoF. BFRI is governed by a Governing Body in which DG of DoF is a member. In this connection, DoF can participate in the operation and decision-making process of BFRI.

2.6. NATP-2 initiative for research-extension linkage

Besides this regular linkage between DoF and BFRI, NATP-2 has introduced some initiatives to strengthen research extension linkage, which are as follows:

- i. Facilitating research-extension linkage through Upazila Extension Coordination Committee (UECC), District Extension Coordination Committee (DECC) and National Extension and Coordination Committee (NECC) meeting: UECC and DECC are the inter-agency committees at Upazila and district level where three extension agencies (DAE, DoF and DLS) researchers, cooperative officers, farmers, etc. are the members who discussed extension program, problem, its solution and coordination of activities. NECC is national levels inter-agency coordination committee that provides strategic guidance to program planning and implementation of project activities.
- ii. Strengthening research-extension linkage through the workshop: Workshop on “Strengthening Research-Extension linkage” organized by PMU, NATP-2 at regional level provided an opportunity for researchers to become familiar with extension programs and farm-level constraints, and an opportunity for extension providers to become familiar with current research and technology available for extension department to disseminate.
- iii. Building partnership between BFRI and PIU, DoF: The PIU, DoF has been working with BFRI to have a supply of genetically pure F1 generation germplasms. Because BFRI has the required knowledge and skill in producing genetically pure F1 of GIF-Tilapia, Vietnamese Koi and Pungas. These germplasms were reared to produce brood fish and ultimately fingerlings in four different government farms of DoF. The fingerlings produced are being disseminated to farmers and hatchery owners. This partnership has definitely strengthened the linkage between extension and research.

- iv. Research extension linkage in FIAC (Farmer’s Information and Advice Center): The FIAC is a unique ‘Farmers Door-step and One-stop Service Center’. Technology advises and extension services are provided through FIAC to the farmers. Leaflets, booklets, posters, brochures, etc. developed by research institutes and DoF are displayed in the FIACs to provide technical information to farmers. This arrangement is facilitating the close linkage between research and extension even at the grass-root level extension service center.

3. Strength and weakness of present research-extension linkage system

Strength:

- i. Government has a good policy and strong support for research and innovation for ensuring food and nutritional security.
- ii. DoF and BFRI are under the same ministry.
- iii. An annual research review workshop is arranged by BFRI once a year in the presence of DoF officers. It helps to identify research priorities and share research findings.
- iv. Qualified extension service providers are present at the Upazila level.
- v. Farmers Information and Advice Center (FIAC) established by the NATP-2 project is furthering extension activities at the doorstep to the farmers.
- vi. The research extension linkage regional workshop organized by the NATP-2 project is helping communication and interfacing between researchers and extension workers.

Weakness:

- i. There is no policy or strategy for a formal research-extension linkage.
- ii. No formal linkage body/committee at the national and regional level.
- iii. Training of DoF-officers on research output is inadequate.
- iv. Lack of qualified extension workers at the Union level.
- v. Insufficient extension workers in DoF.
- vi. Inadequate research and investment.
- vii. Lack of policy for the participation of farmers and extension organizations in research.

4. Gaps and missing links of research-extension linkage

- 4.1. The DoF is responsible for providing inter alia fisheries extension services. In the official organogram, there is no division or section for fisheries extension. At the national level, there is a post of ‘Chief Fisheries Extension Officer (CFEO)’, which is a post of grade 6. This post should be upgraded and a separate extension section/division should be established.
- 4.2. DoF extension services are Upazila-centered. It has no assigned regular extension workers at the Union level.
- 4.3. Training of DoF officers (extension officers) by the technology innovator (researcher) is very rare. This link should be improved.
- 4.4. Extension organization and farmer’s participation is limited in the research process. This situation needs to be improved.

- 4.5. Quality of extension services provided by private organizations needs to be ensured.
- 4.6. Numerous researches are being conducted in different Universities. There are also various action research projects being funded by USAID and other bilateral development partners and those are mostly implemented by a range of national and international NGOs. But the output is found rarely in the field. Research and relevant technologies innovated by Universities and the NGOs under those projects should come to the extension department (DoF) after validation.
- 4.7. Inadequate feedback from extension departments to research organizations.

5. The present policy in research, extension and farmers linkage

Although the National Fisheries Policy, 1998 referred to the formulation of a specific policy on research-extension linkages, it has not yet been implemented. However, a specific policy is necessary to formulate for interaction and cooperation among fisheries research institutes, Universities, extension organizations, and farmers.

Existing research policy as stated in the National Fisheries Policy, 1998 are-

- A specific strategy will be developed for mutual linkage and cooperation between the research institutes and the users' group of the research.
- Emphasis will be given on fundamental research in Universities and applied research in other institutes.
- Collaborative research between public and private organizations will be encouraged.
- Investment by the established commercial fish and shrimp farmers will be encouraged in research.
- Research should be demand-driven so that it can solve existing problems.

Existing extension strategy as stated in the National Fisheries strategy, 2006 are-

- Develop a need-based decentralized extension system.
- Foster the collaboration of other extension providers to achieve the maximum coverage of the target clients.
- Foster the development of private extension services provided by NGOs and other private sector initiatives

Existing research strategy as described in National Fisheries strategy, 2006 are-

Strengthen the knowledge and understanding of the resources through research based on the needs of the sector determined through assessments of the needs of the key stakeholders including the Department of Fisheries:

- In partnership with the key implementers, stakeholders reassess the research needs for the fisheries sector,
- Reassess the research skill base and develop the institutional capacity to undertake the redefined research priorities,
- Ensure the relevance of the research by effecting a sound communication strategy with the key beneficiaries of the research,
- Ensure that strong links are made with international research institutes to stimulate research and feed required knowledge.

Every policy or strategy needs to be updated to address the new challenges. The National Fisheries Policy, 1998 and the National Fisheries strategy, 2006 were formulated more than a decade ago. So, these are required to be updated to cope up with the emerging issues.

6. Sustainable research-extension linkage

Informal linkages can enhance technology innovation and delivery, but a major weakness is their fragility. The absence or removal of a key individual or a project can disrupt the whole linkage chain. Therefore, policies/action plan that address linkages directly and facilitate structural and functional linkages among extension, research, education and producers are needed. Also, different project initiatives regarding research extension linkage need to be mainstreamed. The Government policy or strategy regarding research-extension linkage should be updated so that it can address the emerging issues of the relevant sector.

7. Partnership in extension (Private sector, NGO and Public sector research and extension)

The partnership model is now emerging as a possible solution to the problem of effective technology transfer. The logic behind the partnership approach to development is that multi-faceted, complex problems require more expertise and resources that cannot be provided by a single sector. So, a partnership among the public sector, private sector and NGOs is required for better extension service to the farmers and better management of the natural resources. Hilsa management project jointly implemented by DoF-BFRI and later on, DoF-WorldFish can be mentioned as an example in this regard, which provided satisfactory results.

Fisheries research in the private sector has not been flourished yet. However, WorldFish Center and some other NGOs conduct research in the fisheries sector. The government should encourage private sector research by building partnerships with them and facilitating proper policy support.

Private extension service providers are sometimes more flexible, motivated, cost-conscious, and client-oriented, thus potentially providing more effective services at a lower cost and on a sustainable basis. But they are also often criticized for their inefficiencies and the quality of service is a concern. If the quality of service is ensured, there is no doubt that partnership in an extension would provide better extension service to the farmers.

8. Successful linkage among research, extension and NGOs

A successful linkage among research, extension and NGOs was found in Hilsa fishery management. Hilsa shad (*Tenualosa ilisha*) is the largest single-species capture fishery of Bangladesh. However, this important fishery declined in the early 2000s that led the Government to formulate the Hilsa Fishery Management Action Plan (HFMAP) and started its implementation in 2005. At first, the program was limited only to juvenile Hilsa (locally called Jatka) conservation. As a result, Jatka catch, transport and storage were banned for a certain period of a year. Later, expert opinions rose to conserve mother Hilsa as well, so that Hilsa spawning can occur uninterruptedly which will ultimately enhance the natural production of this fish. The most important part of this strategy is to ban the fishing of Hilsa during the peak breeding season of this fish in Bangladesh waters. As a result, correct and pinpoint identification of the peak breeding season of Hilsa has become very important. Upon receipt of research outputs on Hilsa breeding season from BFRI, DoF implements

Hilsa fish ban policy in Bangladesh waters. The peak spawning season was identified around the full moon in October (Awshin month in Bangla) (Rahman, 2020). Since the full moon occurs at a different English date, every year the exact date is declared through a notification by the MoFL based on the recommendation of BFRI and WorldFish (Ecofish Project). In the beginning, the banning period was 11 days, before and after 5 days of full moon in October. But the banning period is extended to 22 days following a recommendation that

came from BFRI. With the successful implementation of the brood hilsa protection program along with the other management measures, Hilsa production has been increased from 1.99 lakh MT in 2002-03 to 5.33 lakh MT in 2018-19 (DoF, 2019). Now, this single species contribute about 12% of the total production and Hilsa management has been considered as a role model of fishery management.

9. Way to improve and strengthen research and extension for effective delivery of technology and service

- i. The use of ICT in the extension process should be strengthened.
- ii. Technology demonstration should be the mainstreaming activity of DoF. Now, it is only done by the projects. It should also be done by revenue budget.
- iii. The existing set-up of extension services in DoF headquarter (HQ) under ‘Chief Extension Officer’ (Grade 6) should be reformed and strengthen with manpower under a Director (Grade 3) or at least a DD (Grade 4).
- iv. DoF should increase manpower and logistics from the field level to HQ to dispense better extension services to the stakeholders.
- v. BFRI’s capacity needs to increase so that it can conduct need-based research. Besides aquaculture, it should also focus on open water, marine and brackish water and value-added product development research.
- vi. The uses of aqua inputs and drugs should be monitored and controlled with strong collaboration among industries, research and competent authority (DoF).
- vii. For effective and sustainable technology transfer, safe and market-driven aquaculture production practices, NATP introduced the CIG approach along with Agricultural Innovation Fund (AIF), which should be adopted by the DoF in all relevant fields.
- viii. NATP’s producer organization is a good approach for technology expansion and strengthening market access of small and marginal farmers. It could be institutionalized.
- ix. Provision of DoF’s extension personnel at the Union level should be made.
- x. Local Government institutions need to be more functional for the effective expansion of modern technologies.

10. Recommendation and way forward

- i. A research-extension linkage policy, strategy and action plan should be formulated to institutionalize the linkage system. DoF, BFRI and BFDC should jointly initiate the process immediately with the assistance of BARC;
- ii. Research Need Assessment (RNA) should be conducted in a more participatory way by BFRI, DoF, Universities and relevant stakeholders. BFRI should organize several regional workshops and a central workshop for research program planning;
- iii. Research issues should be identified and prioritized based on extension feedback, farmers demand, government policies and plans, SDGs targets along with market-led production systems. Agricultural Research Vision 2030: A Vision Document-2030 for Agricultural Research in Bangladesh published by BARC in 2012 need to be considered;
- iv. Participatory technology generation should be encouraged;
- v. BFRI, DoF and Technology Transfer and Monitoring Unit (TTMU) of the Bangladesh Agricultural Research Council (BARC) should take initiative in technology screening and packaging for dissemination;

- vi. A National Technical Committee (NTC) and Divisional Technical Committee (DTC) should be formed comprising of researchers from BFRI, Universities, DoF, NGOs and farmer's representation;
- vii. Technologies generated by research institutes and Universities should be validated with the active participation of DoF, other extension personnel, relevant experts and farmers, and their feedback should be addressed;
- viii. Training of Trainers (ToT) should be arranged regularly by BFRI and other concerned organizations on newly developed technologies at training centers of BFRI and DoF;
- ix. Enhancement of public-private partnership engaging related GOs, NGOs and Private organizations in the process of diffusion of fisheries technologies, entrepreneurship development under the leadership of BARC;
- x. BFRI should establish its own technology outlet/wing as a hub of technology validation and dissemination with the active participation of research, extension and private organization's personnel/representatives;
- xi. Technology handbook should be published regularly in two years interval by BFRI;
- xii. Institutional capacity building of BFRI and DoF should be strengthened; extension worker should be employed at Union level;
- xiii. GoB funds for technology generation and dissemination should be sufficient and continuous.

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Research Extension Linkage Strategy of the Department of Livestock Services (DLS): Present Status, Strength, Weakness of Technology Transfer and Way Forward for Improving the Linkage

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Abstract

Research, extension, and farmers are the three main components of livestock production system and their effectiveness largely depends on the strong linkages among each other. This paper indicates that top-down research activities and extension management, lack of budgetary provisions to provide incentives for linkage activities, high turnover of development agents, poor infrastructural developments, and inadequate skills of the development agents are the main causes of weak research, extension and farmers linkages in Bangladesh. A SWOT analysis was carried to identify strength, weakness, opportunity and threats of research and extension linkages. The analysis points out that there should be adequate allocation of budgets and the provision of better incentive mechanisms for linkage activities, research should be planned using bottom up approach and more towards farmer's problem oriented, research and extension management systems should be made more robust through the expansion of infrastructural facilities for exploiting the potentials of the strengths of livestock sub-sector which is crucial for the aspired transformation of the sub-sector. This paper describes the present status of research and extension linkages of DLS, further discovers the strength and weakness of technology transfer methods and suggests way forwards for improving the current condition of linkages.

Keywords: Research, extension and farmer's linkage, livestock, sustainability, DLS.

1. Introduction

Research, extension and farmers are the three main pillars of livestock production system and their effectiveness largely depends on strong linkages among each other (Figure 1). Hence, strong interaction and effective collaboration among all the stakeholders are essentially needed to achieve the common objective of sustainable livestock production and uplift the living standard of the rural poor (Kassa & Alemu, 2016; Sewnet, et al., 2016). Livestock researches without appropriate linkages to the extension providers may neither be aware of the difficulties faced by farmers (knowledge of which is crucial to formulating appropriate research) nor know how their findings are applied in the field (Chikaire et al., 2011).

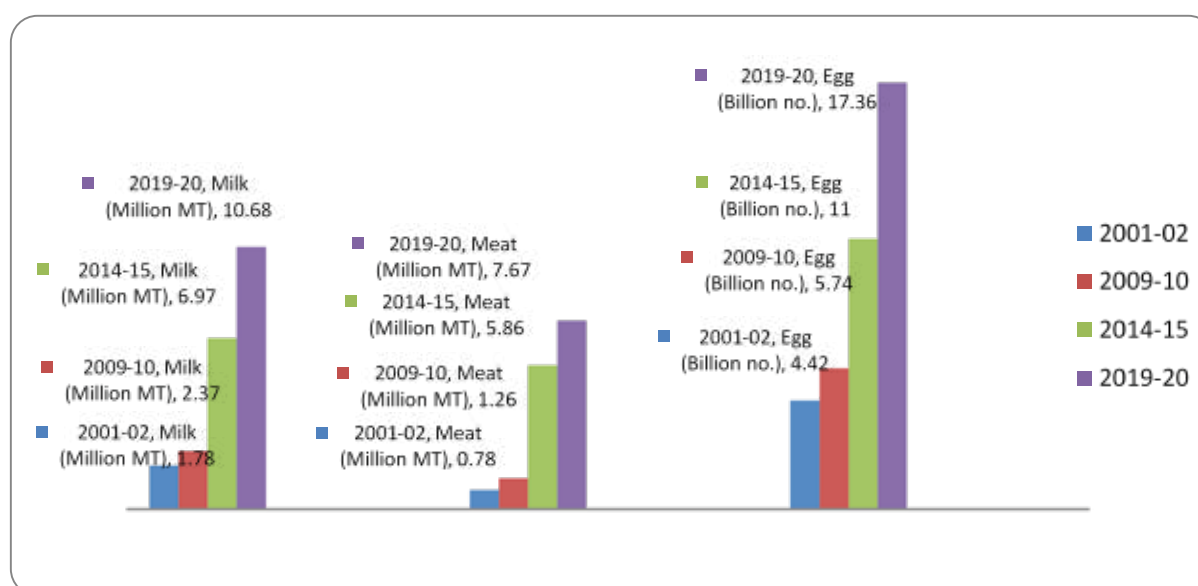
Livestock is a strategic sector of the agricultural economy of Bangladesh, performing multifarious roles. At present, the increasing demand for safe and nutritious food leads to a process of intensification in livestock production, which can lead to a golden opportunity to the livestock industry. About 20% people directly and 50% people indirectly depend on livestock for their earnings. In 20 years' time (2001-02 to 2019-20) production of milk, meat and eggs has been increased by about 6, 10 and 4 times (Figure 1) and Bangladesh has achieved self-sufficiency in meat and egg production. However, there is still about 30% deficit in milk production (Table 1).

Table 1: Demand , production and availability of milk, meat and eggs (2019 -20) *

Name of the Products	Demand	Production	Availability
Milk	152.02 Lakh Metric Ton (250 ml/day/head)	106.80 Lakh Metric Ton	175.63 (ml/day/head)
Meat	72.97 Lakh Metric Ton (120 gm/day/head)	76.74 Lakh Metric Ton	126.20 (gm/day/head)
Egg	1732.64 Crore number (104 number/year/head)	1736.43 Crore numbers	104.23 (number/year/head)

* The estimated population of the country on 1st July, 2019: 16 crore 66 lakhs

Figure 1: Production trends (2001 -02 to 2019-20) of milk, meat and eggs



Source: Department of Livestock Services and Bangladesh Economic Review (BER, 2020)

A number of multilateral activities and initiatives have been taken by this sub-sector for sustainable livestock development. The most important activities include: a) Extension of breed up gradation program through artificial insemination using superior quality semen, b) Vaccine production & distribution for preventing diseases, c) Providing treatment and diagnostic services, d) Distribution of chicks and ducklings at subsidized rate among the stakeholders, e) Providing training on new/matured technologies for technology transfer to the farmers, f) Entrepreneur's development etc. Nowadays, cattle fattening techniques through feeding urea molasses straw (UMS), silage preparation and conservation, hydroponic/floating bed fodder cultivation have become very popular to the livestock farmers and these are being practiced throughout the country with the assistance of livestock sector extension workers. Extension workers have also been able to motivate farmers to cultivate fodder crops (perennial and seasonal) for their animals. The cumulative effect of all the activities of livestock extension department is evident from the fact that Bangladesh has become self-sufficient in sacrificing animal production and the country is able to supply all the animals needed for Eid-ul-Azha (out of

the total number of animals slaughtered throughout the year about 50% is slaughtered during this time) without importing any animals from foreign countries for the last 5 years.

Despite all these achievements, livestock sub-sector is suffering with the problems of weak research-extension-farmer linkages; there also exists poor inter-organizational relationship in Bangladesh which is hindering the overall progress of this sub-sector. The aim of this paper was therefore, to assess the present status of research, extension and farmer linkages, strength and weaknesses of the Department of Livestock Services (DLS) in technology transfer and to suggest the areas of improvement for effective linkages. In this circumstance, SWOT analysis is done for find out DLS strength, weakness, opportunity and threat for further improving research extension linkage for sustainable livestock production.

2. Present status of research extension linkage of DLS

Department of Livestock Services (DLS) is doing their activities under the direct supervision of Ministry of Fisheries and Livestock (MoFL). The main role of DLS is to provide extension services to the farmers. Within the same ministry there is a separate institute, the Bangladesh Livestock Research Institute (BLRI) which is the national institute for livestock research in the country with different organizational structures and operational procedures. BLRI in general, is responsible for conducting farmer's problem-oriented research and technology generation (Draft National Livestock Extension Policy-2012). There are several agricultural universities conducting livestock research for academic purposes and in collaboration with national research institutes they are also engaged in conducting applied type of research for livestock development. Bangladesh Agricultural Research Council (BARC) under the Ministry of Agriculture (MoA), the apex body of the National Agricultural Research System (NARS) is responsible for coordination of agricultural researches conducted by the different NARS institutes including BLRI. BARC through its Technology Transfer and Monitoring Unit (TTMU) is also responsible for coordination of technology dissemination activities of the extension departments in collaboration with the NARS institutes.

Figure 2: Relationship among farmers, researchers and extension workers (Agriculture Research Extension linkage -1996)



3. Strength, weakness, opportunity and threat (SWOT) analysis of research extension linkages of DLS

Strength:

• Animal resources:

The livestock sector in Bangladesh is a great example of the new possibilities that can arise from the crisis. Even few years ago, a large part of the country's demand of cattle was met by imports from neighboring India and Myanmar. But, since 2014 due to trade embargo, cattle from India stopped coming to Bangladesh. This has led to a massive increase in cattle and goat production in Bangladesh (Table 2) to fulfill the market demand of meat. Bangladesh is now self-sufficient in meat production.

Table 2: Livestock Population in Bangladesh

SI. No.	Species	Numbers (Millions)			
		2001-02	2009-10	2014-15	2019-20
1.	Cattle	22.46	23.05	23.64	24.39
2.	Buffalo	0.97	1.35	1.46	1.49
3.	Goat	16.96	23.28	25.60	26.44
4.	Sheep	2.20	2.98	3.27	3.61
5.	Chickens	152.24	228.04	261.77	296.60
6.	Duck	34.67	42.68	50.52	59.72

Source: Department of Livestock Services and Bangladesh Economic Review (BER, 2020)

Bangladesh is a home to various cattle breeds and their crosses. Although it is hard to distinguish between the breeds, as farmers do not keep accounts of the cattle being bred, they can be identified based on their phenotypic characteristics. The most commonly found breeds in the country are Native, Sahiwal, Sindhi, Holstein-Friesian, Jersey, Brahman, Red Chittagong Cattle, Pabna Cattle, and Mirkadim Cattle.

• Infrastructural facilities at field levels:

Under the Department of Livestock Services extension and diagnostic services are available, in some cases, up to Union level. Director (Extension) coordinates all the extension activities at field levels. There are 8 Divisional offices, 64 District offices, 501 Upazila and metro offices, 10 Regional Field Disease Investigation Laboratories, 21 District Artificial Insemination Centers, 4464 AI points, 50 Poultry farms, 7 Goat farms, 3 Sheep farms, 1 Pig farm, 7 Dairy farms and 2 Zoological gardens. Field level offices closely work with the stakeholders for ensuring sustainable livestock production.

• Priority based development projects:

The government of Bangladesh through the Department of Livestock Services (DLS) has taken initiatives to increase investment in the livestock sector for the desired and sustainable development of livestock in the country. During 2019-20 fiscal year a total of 19 projects were implemented by the DLS with the aim and objectives of the projects. To ensure sustainable livestock production, most of the projects were implemented at the field level. Furthermore, there are about 16 projects in the pipeline aligned with the 8th Five Year Plan (FYP) and Sustainable Development Goal (SDG) action plans.

• Innovation and digital services:

To take services to the door steps of the farmers and for sustainable livestock production, a total of about 26 innovations have been developed by the DLS staff. Of them E-vet service, SMS gateway, online farm

registration is most important. Access to Information (a2i) program has been adopted for digitalization and simplification of Artificial Insemination Services. This activity is being implemented at the Nalchiti Upazila of Jhalokati. Animal health care centers have been set up in the Unions of 80 Upazilas and service delivery activities are underway in those centers. The “Animal health Camp” is another example of innovation for service simplification program by DLS that has recently been completed its activity for prevention and control of livestock diseases through vaccination and treatment.



Figure3: E-vet service

• **Women’s participation in livestock sector:**

Women empowerment is one of the priority areas of the government of Bangladesh and livestock sector with the leadership of DLS is playing an important role to achieve gender equity through attracting more and more women in livestock keeping activities. Involvement of women in livestock development activities helps to empower women through increased household incomes and the nutritional status of the household (FAO, 2011). Women empowerment status was increased due to government patronage, necessary logistical support and relentless efforts of the DLS. More than 50% women participate in livestock total population (Jaimet, al., 2011). Women are now playing a greater role in the socio-economic development of the country and in family decision making than ever before. As a result, the supply of animal protein at the family level is increasing as well as financial empowerment is being created through livestock products marketing.



Figure 4: Distribution of 5% interest credit to the dairy farmers by the honorable Prime Minister



Figure 5: Participation of women in livestock production activity

• Source of renewable energy:

Livestock is thus an integral component of agricultural economy of Bangladesh performing multifarious functions such as provisions of food, nutrition, income, savings, foreign currency earning (by exporting hides & skin, bone and other products), draft power, manure, fuel, transport, social and cultural functions (MoEF, 2009). The increasing demand for food leads to a process of intensification in livestock production, which can lead to serious environmental problems if animal manure is not managed properly. Biotechnological interventions including ongoing practices of anaerobic digestion, for diversification and upgrading of value-added products (Organic fertilizer/soil conditioner, Bio-power, Compressed biogas, Vermi-composting, Organic pesticide) from manure could provide cleaner production practices and make livestock farming socioeconomically and ecologically sustainable. But the problem is that, livestock waste management in Bangladesh is very inefficient, where manure is managed traditionally. As a result, a large volume of gases, organic material, bacteria, and other substances that are produced from the manure posing a great risk for air, soil, and water contamination. Improved livestock manure management reinforcing the planet pillar of sustainable livestock production (Bhandari et al., 2016) needs to be established in Bangladesh.



Figure 6: Biogas plant at rural area

Weakness:

During SWOT analysis we found out some weaknesses. are given below:

- Research activities performed are not in accordance with the priority needs of livestock producers
- Knowledge generated from research are not effectively transferred to the producers
- Lack of database and strategic planning
- Inadequate policy support
- Inadequate preparedness for planning of emerging and re-emerging diseases
- Shortage of budget and absence of livestock insurance systems
- Inadequate technology validation

Opportunities:

The two important issues- i) farming system network and ii) data base development are new avenues for the

development of research and extension linkages. The concept of farming system networking is well understood by all over the world. The ideas have been originated from International Farm Comparison Network (IFCN) which was established in 2000 and now has been working in the University of Kiel, Germany which is a global network of researchers, livestock stakeholders and entrepreneurs in the livestock and dairy production chain.

The networking is closely associated with data base development. Data is a power which is lacking in Bangladesh. Until today, Bangladesh is emphasizing on the development of data base, however, this might inquire to have appropriate methods, models and data base development. The introduction of livestock networking could be way forward for mitigating the authentic data shortage. The networking is able for providing a mechanism for bringing all researchers and farmers with valuable stakeholders in the same platform for the development.

Threats:

In the current National Livestock Development policy is not properly addressed the research and extension linkage. The policy needs to address the farm category and way forward for the implementation of research output to the farm level. Lack of coordination between research institutions and regulatory body is another threat for the development of linkage.

4. Gaps and missing of research extension linkage

- Inadequate research and data management
- Insufficient Livestock Extension Services
- Imbalance supply chain
- Insufficient Veterinary and Animal Health Care facilities
- Limited Access to Credit and absence of provision for subsidy
- Challenges of Climate Change effect on livestock production
- Limited Manpower in DLS
- Shortage of training and demonstration

5. The present policy in research, extension and farmer linkage

Livestock is an important sub-sector of Agriculture. The strength of the public sector is in the development and provision of a “facilitating environment” such as policy formulation, regulation, promotion and quality assurance of “private sector goods” which by its nature will not be taken up by the private sector and the NGOs on their own. Government of Bangladesh has adopted the following policies and promulgated Acts to enhance Milk, Meat and Egg production, generation of employment and to ensure public health and safety issues:

- National Livestock Development Policy, 2007
- National Poultry Development Policy, 2008
- National Livestock Extension policy (draft), 2012
- Animal Slaughter and Quality Control of Meat Act, 2011
- Fish feed and Animal Feed Act, 2010
- Animal and Animal Products Quarantine Acts, 2005
- National Integrated Livestock Manure Management (ILMM) Policy (draft), 2015
- Animal Welfare Act, 2019

- 8th Five Year Plan (2021-2025)
- 2nd Perspective plan (2021-41)

In the future, DLS needs to revise the draft livestock extension policy for properly disseminating research findings. Besides, livestock policy should focus on the following issues:

- Strengthening public-private investments
- Veterinary public health and food safety issues
- Producer organization based demonstration and adoption
- Supply chain development for forward linkage
- Success in dissemination of models and technologies
- Strong linkage among research, extension, education and farmers

6. Sustainable research extension linkage

Livestock extension is the primary delivery system for information to farmers. Improving livestock production may not be achieved without relevant and reliable agricultural information. Livestock extension has the potential to stimulate livestock development and is often used as a tool for implementing government policies. A technology is considered successful when it is accepted by the farmers at the field level. Success of technologies generated by the research institutes often depends greatly on active participation of the extension agencies in transferring the technologies to the farmers. There are some research ideas and extension tools for improving research extension linkages for sustainable livestock development:

- Generate need-based technology and improve livelihood of livestock farmers through adaptive research
- Transfer developed technologies to users through training of extension workers, planners, livestock farmers and other stakeholders
- Ensure research demonstration at field level frequently
- Awareness development of farmers about the benefits of technology through proper demonstration
- Develop climate resilient and least cost feeds and fodders
- Conserve and improve indigenous genetic resources that are adopted to our climate
- Climate Smart or Resilient Livestock/Poultry Breed Development

7. Partnership in extension (Private sector, NGO and Public sector research and extension)

Efforts to transfer livestock technologies to farmers are more effective when the state (GO), non-governmental organizations (NGOs), and private sector organizations (POs) work in partnership. Department of Livestock Services (DLS) has partnership with the various organizations for fostering livestock productivity. DLS having partnership with:

- Public and private universities
- Bangladesh Livestock Research Institute (BLRI)
- Bangladesh Agricultural Research Institute (BARC)
- Bangladesh Bank and Financial Institutions
- International organization
 - o Food and Agricultural Organization (FAO)
 - o World Organization for Animal Health (OIE)

- o World Bank (WB)
- o International Fund for Agricultural Development (IFAD)
- o U.S. Agency for International Development (USAID)
- o Japan International Cooperation Agency (JICA)etc
- NGOs
 - o PRAN,
 - o BRAC,
 - o PKSF etc.
- Stakeholders
 - o Bangladesh Poultry Industry Central Council (BPICC)
 - o Bangladesh Dairy Farmers' Association (BDFA)
 - o World's Poultry Science Association- Bangladesh Branch (WPSA-BB)
 - o Animal Health Companies Association of Bangladesh (AHCAB)
 - o Feed Industries Association of Bangladesh (FIAB)
 - o Bangladesh Poultry Industries Association (BPIA) etc.

8. Way to improve and strengthen research and extension for effective delivery of technology and services:

Linkages are channels for the two-way flow of information, knowledge and resources among the stakeholders of a defined system. The key functions that any linkage system should perform include diagnosis, planning and review of programs; execution of collaborative tasks; exchange/sharing of resources; dissemination of information/knowledge; evaluation, feedback and coordination. The following way to improve and strengthen livestock research and extension:

- The ultimate objective of both research and extension systems is to increase livestock production.
- Their roles of generating and transferring technology are complementary.
- Research institutions need to have information on the problems, technology requirements and socio-economic and ecological environment of producers to formulate research agendas and to set priorities.
- Formulating a research agenda based on producers' requirements results in technology that will be more acceptable to users; this also leads to research institutions allocating their resources more efficiently.

9. Recommendation and way forward

The recommendations and way forward adopted from the “Research-Extension linkage and policy development workshop of BARC for improving research extension linkage in livestock sector in given below:

- i. A research-extension linkage policy, strategy and action plan should be formulated to institutionalize the linkage system. Bangladesh Livestock Research Institute (BLRI) and DLS jointly should initiate the process immediately with the assistance of BARC;
- ii. Research programs should be planned in participatory way involving BLRI, DLS, Universities and other relevant organizations. BLRI should organize regional and central research review workshops regularly for research program planning;
- iii. Research issues should be identified and prioritized based on the feedback from the extension agencies, farmers demand, government policies and plans, SDG targets along with market-led production systems. The “Research Priority in Bangladesh: A Vision Document on Agriculture for

2030 and beyond” published by BARC in 2011 also need to be considered;

- iv. Participatory technology generation should be encouraged, technology generation and dissemination should be location specific and market oriented
- v. Bangladesh Livestock Research Institute (BLRI) and TTMU, BARC should take initiative in technology screening and packaging for dissemination;
- vi. National Technical Committee (NTC) and Divisional Technical Committee (DTC) should be formed comprising of researchers from BRLI, Universities, DLS, NGOs private sector and farmer’s representative;
- vii. Technologies generated by research institutes and universities should be validated with the active participation of extension personnel, relevant experts and farmers and their feedback should be addressed;
- viii. Training of Trainers (ToT) should be arranged regularly by BLRI and other concerned organizations on newly developed technologies;
- ix. Public-private partnership should be enhanced engaging related GOs, NGOs and Private organizations in the process of diffusion of livestock technologies, entrepreneurship development under the leadership of BARC
- x. Bangladesh Livestock Research Institute (BLRI) should establish its own technology outlet/wing as a hub of technology validation and dissemination with active participation of research, extension and private organization personnel/representatives;
- xi. An extension manual is needed to be prepared for strengthening research and extension linkage by DLS
- xii. Strengthening the existing farmers group/organization as well as new groups need to be formed through DLS for large scale pilot production and adoption of technologies, market linkage, value chain and feedback
- xiii. A policy guideline should be developed for strengthening research-extension-education linkage;
- xiv. Technology handbook should be published at regular intervals by BLRI;
- xv. Human resources of BLRI and DLS should be strengthened up to union level;
- xvi. GoB fund for technology generation and dissemination should be sufficient and continuous.

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Research Extension Linkage Strategy of University: Present Status, Strength and Weakness of Technology Transfer and Way Forward

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Abstract

Agriculture in Bangladesh is characterized mostly by smallholders farming whose access to modern technology and basic education is not so satisfactory. Research, extension, education and farmers are the main pillars of agricultural innovation systems and their effectiveness largely depends on strong linkage among each other. However, the existing research-extension-education linkage has not been effective. Our research-extension system is at a reasonable level impacting the increased agricultural production and productivity, although the research-extension-linkage needs strengthening to face future food challenge. Thus, the purpose of this review is to point out the major challenges for effective linkage among Research, Extension and Education (REE) and propose some recommendations for better linkages. The policy framework that synergizes the relevant actors' linkage in a sustainable manner should be in place to bring the intended growth and transformation in agriculture through appropriate innovation.

Keywords: *Research extension linkage, agricultural university, technology transfer*

1. Introduction

Agriculture is the source of diverse selective forces, and modern agriculture – its species and practices, is the outcome of a continuous process of change that has dramatically changed physically and genetically all components of agro-ecosystems. Further advances in the genetic potential of crops and livestock will continue to be dominated by conventional breeding strategies made increasingly efficient by advances in marker technologies (Thrall et al., 2010). To sustainably meet these increasing demand for food (FAO, 2016), agricultural systems will need to transition away from the dominant industrial agriculture paradigm designed for production, self-sufficiency, efficiency and affordability (Prost et al., 2017) to one of sustainable agriculture that “conserves land, water, and plant and animal genetic resources, and is environmentally non-degrading, technically appropriate, economically viable and socially acceptable” (FAO, 1989).

In the changing agricultural development context in developing countries, learning in innovation processes is important to address challenges and opportunities facing smallholder farmers (World Bank, 2006). The imperative for learning in innovation is linked to recent insights on innovation processes as knowledge-intensive, interactive and inherently unpredictable, and accompanied by risk, conflict and uncertainty (Hall and Clark 2010; Leeuwis and Aarts 2011; Smits, 2002). Following these insights on innovation, it has become recognized that if agricultural innovation is to be adequately supported, it is necessary to re-conceptualize advisory services as a broad range of innovation support services (Christoplos, 2010; Leeuwis and Van Den Ban, 2004). These should be provided in response to growing demands from farmers and other stakeholders (demand-driven) and cover a varied range of support services. These include articulating innovation needs, accessing knowledge and technologies, enhancing entrepreneurial capacity, building multi-actor linkages and networks, facilitating action learning and experiments (for example, Farmer Field Schools), organizing farmers and mediating conflict (Christoplos, 2010; Klerkx and Leeuwis, 2008;

Rivera and Sulaiman, 2009). Establishing an adequate match between demand and supply of these various innovation support services is important, especially in the context of smallholder agricultural development in Asia where the sector is hampered by various socio-technical and institutional challenges (WB, 2007).

These entire networking and learning actions take place in an enabling environment created through different policies and strategies by the concerned organizations. There should have due linking scope and strength of concerned stakeholders in order to achieve the set targets in innovation networking.

Agricultural innovation is the process whereby individuals or organizations bring existing or new products, processes and forms of organization into social and economic use to increase effectiveness, competitiveness, resilience to shocks or environmental sustainability, thereby contributing to food and nutritional security, economic development and sustainable natural resource management (TAP, 2016). While, *agricultural innovation systems* (AIS) is a network of actors or organizations, and individuals, together with supporting institutions and policies in the agricultural and related sectors, that brings existing or new products, processes, and forms of organization into social and economic use. Policies and institutions (formal and informal) shape the way that these actors interact, generate, share and use knowledge, as well as jointly learn. In the context of a growing world population and climate change, agricultural innovation has a high potential to increase farmers' income, improve food security and allow for a sustainable management of natural resources. As agriculture increasingly involves complex interactions of environmental and socio-economic factors with stakeholders at multiple levels, innovation needs an AIS perspective. The AIS comprises four components: research and education; bridging institutions; business and enterprise; and the enabling environment.

The AIS entails explicitly the integration of various institutions and their possible roles towards achieving a sustainable agricultural development in a country. The overall supports needed from policy environments are also shown as integral part of the process. In making the learning and networking environment capable enough, the universities, research organizations and extension/advisory service providers have been playing their informal roles to boost agricultural production in the country. But, due to the absence of legitimate linkages among these institutions the real benefits of the integrated system approach could not be accrued appropriately.

In Bangladesh, the agricultural universities are under Ministry of Education which have no direct linkages with Ministry of Agriculture resulting in poor linkage and weak coordination with agricultural extension and research system. And possibly, we lack adequate information and understanding about potential research-extension and education linkages. Thus, the paper seeks the main aim to explore the linkages of higher educational institutes with research and extension towards achieving a sustainable agriculture. Specifically, it envisages looking into the matters of existing situation of linkages and their strength and weaknesses, future potentialities and suggestions for developing sustainable linkages and way forward to achieve them.

2. Present state of research extension linkage in relation to Agricultural and Science & Technology Universities

Linkage implies the communication and working relationship established between two or more organizations pursuing commonly shared objectives in order to have regular contact and improved productivity. It is evident that manpower training is the primary mission of higher education institutes. However, in addition to their primary function, they are expected to play a developmental role by establishing linkages with public, private and non-government organizations engaged in agricultural and rural development and with farming

communities. Popularly, the agricultural universities are established with three major missions: education, *research and extension*.

Let us view the condition of linkages at Universities where agricultural disciplines are taught. The concerned universities are:

- Bangladesh Agricultural University (BAU)
- Sher-e-Bangla Agricultural University (SAU)
- Bangabandhu Sheikh MujiburRahman Agricultural University (BSMRAU)
- Sylhet Agricultural University (SAU)
- Patuakhali Science and Technology University (PSTU)
- Hajee Mohammad Danesh Science & Technology University (HSTU)
- Rajshahi University (RU)
- Khulna University (KU)
- Chittagong Veterinary and Animal Sciences University (CVASU)
- Noakhali Science and Technology University (NSTU)
- Bangabandhu Sheikh Mujibur Rahman Science and Technology University (BSMRSTU)
- Khulna Agricultural University (KAU)
- Bangamata Sheikh Fojilatunnesa Mujib Science & Technology University (BSFMSTU)

BAU has its Agri-Varisty Extension Project (AEP) since 1976 which finally took its formal shape as BAU Extension Center (BAUEC) in 1989. The main objectives of this center are to construct bridge between the nearby rural people of Mymensingh Sadar Upazila and BAU, and to accelerate the extension support services with the close co-operation of different GOs and NGOs. To achieve mission statement of BAUEC “facilitate farmers’ access to timely and demand led information on various aspects of agriculture and rural development for improvement of living standard by involving various stakeholders focusing on human needs irrespective of age and gender in rural as well as peri-urban and urban fringes”, it has been implementing different programs with community people regularly through forming rural society (Grameen Somitee). There are 43 associations (each consists of 40 members both male and female), out of which 40 associations are in Mymensingh sadar upazila and 3 associations in Gouripur upazila where agricultural extension and other community development activities are being carried out by the BAUEC (<https://bauec.bau.edu.bd/>). Apart from that, BAU has its Graduate Training Institute (GTI) to facilitate trainings for their graduates and others in the allied fields. This assists in developing technical skills to the graduates and ultimately serves towards better advisory services in the field of agriculture.

SAU Outreach Program accounts for transfer of technologies innovated by agricultural research institutions and SAU Research System. The Outreach Program also offers training to farmers, agricultural professionals and teachers, organizes farmers’ group, identifies production problems and offers solutions, maintains link with national extension services, research organizations, NGO’s and other universities as well. Publishes newsletters on extension activities undertaken by the Outreach Program and produces extension materials for teaching rural farmers (<http://www.sau.edu.bd/offices/outreach>).

BSMRAU outreach center was established in 1985 which is now renamed as Kbd. Dr. Kazi M. Badruddoza Outreach Center. The main objective of this center is to disseminate and transfer generated technologies at BSMRAU through training and on-farm activities at farm levels (<https://bsmrau.edu.bd/doutreach/>). It has demonstration plots at Toke, Kapasia and conducted some technical training so far.

SAU, Sylhet does not have any outreach program yet although they are planning for it. What only they have

the Professor Mosleh Uddin Ahmed Chowdhury Veterinary Teaching Hospital (<http://www.sau.ac.bd/pages/view/249>) which provides services to the animals of the farmers. It simultaneously serves as a learning opportunity for the students and the concerned researchers.

PSTU also does not have their outreach programs. It has Research and Training Center (<http://pstu.ac.bd/offices/rtc>) but the website did not describe any of its activities.

CVASU has its institutes like Poultry Research and Training Centre (PRTC), One Health Institute, Coastal Biodiversity, Marine Fisheries and Wildlife Research Centre. Moreover, it has research and off-campus centers as Teaching and Training Pet Hospital and Research Center, Research and Farm-based campus and CVASU Research Vessel. But there is no direct technology dissemination mechanism in a form of extension center.

The **KU** and **KAU** websites did not show any outreach activity. Same are the cases for **RU**, **BSFMSTU**, **NSTU** or **BSMRSTU**.

The graduates produced from all these universities on agriculture disciplines are taught with agricultural extension education. Even some of the graduates are specialized through acquiring MS and PhD from these disciplines. All they have been serving at different institutes towards achieving targets of the agricultural development in the country. Thus, a formal academic contribution, in one sense linkage, has been offered through their services.

3. Strength and weakness of present research-extension linkage system at universities

The very meaning of extension is extending university education in a non-formal way to the surrounding community or to the rural sector to improve the lives of farmers (Davis, 2009). Research focuses on the technical aspects for generating useful technologies, while extension focuses on the acceptance and adoption of those technologies by users (Agbamu, 2000; FAO, 2005). Until recently, extension has the weak link at the university because of a lack of appreciation of the extension role of education institutions. That also implies a low link between education and extension.

Research, extension, education and farmers are the main pillars of agricultural knowledge systems and their effectiveness depends on strong linkage among each other. The existing education-research-extension linkage is poor or not effective. The lack of strong linkage causes disruption in technology flow and low adoption rates, reduced efficiency in the use of resources, and increased cost of agricultural research and extension activities (Ashraf et al., 2007). Linkages are facilitated when research, extension and education institutions see the value of shared or complementary information.

Anyway, the major strengths of the institute of higher education in agriculture (IHEA) (i.e. agricultural universities/colleges) may be pointed as:

- Highly competent faculties with higher study knowledge and skill from universities abroad
- Some are highly experienced and contributing with due expertise
- A satisfactory teacher-student proportion
- A good number of agricultural universities or ag-disciplines in universities
- Graduates produced every year from different universities are of very good number
- Agriculture degree holders have the due knowledge of Agricultural Extension and Farm Management and Research Methodologies

- Graduates of the IHEA have been serving the country as extension agents, development workers, subject matter specialists, teachers, researchers, experts, heads of different offices, consultants, etc.
- Quite a good number of quality research through academic ways like MS or PhD
- Some high-class and cutting-edge researches have been conducted at IHEA through funding supports of national (e.g. NATP, KGF, BAS) and international (WB, FAO, USDA, EU, IFAD etc.) donors.
- Some university teachers have international exposure with Global Forum for Rural Advisory Services (GFRAS), Asia-Pacific Islands Rural Advisory Services (APIRAS), Agricultural Extension in South Asia (AESAS) and others. Bangladesh Agricultural Extension Society (BAES) and Bangladesh Agricultural Extension Network (BAEN) are closely associated with these international rural service providing organizations.

In addition to their direct involvement in agricultural research activities, the IHEA have been contributing to research capacity development of the country mainly through producing qualified manpower for the NARS and upgrading the professional skills of NARS staff through short-term and in-service training programs.

Weaknesses facing IHE in agriculture and related fields differ from one institution to another and are a bit complex and diverse. Yet, there are some common issues applicable for all the IHEA for Bangladesh. These weaknesses may be:

- NARS is the system for linking among agricultural research organizations. But there is no organization or system to link the agricultural extension organizations like the NARS.
- IHEA is not linked formally to NARS (under MoA) as the IHEA undergo the MoE
- No formal link to extension and advisory services at district or regional levels
- Limited research facilities of adaptive/applied research and the effective application of research findings in the field is questionable, sometimes
- Although most of the faculties at the IHEA are competent enough, there are some reluctant and not qualified up to the level which act as bottle-neck in the total academic environment
- Shortage of supplies/equipment and inadequate facilities
- Sometime narrowly focused programs of the study (lacks interdisciplinarity)
- Weak inter-institutional linkages
- Weak connection with other parts of the agricultural education system
- Lack of communication with key stakeholders
- Little evidence was found the linkage between academic education and extension except for growing demonstration plots.

4. IHEA in national research and extension systems: the missing links

Whether the agricultural research succeeds or fails as a catalyst to any nation's development depends largely on how well researchers and extension personnel communicate and cooperate with each other. In this regard, close and reciprocal interaction among research, extension and farmers is mandatory which could lead to design and delivery of appropriate technology. Thus, the status of linkages between research and extension, extension and farmers and research and farmers has been highlighted in top agricultural agenda and also the indicators which could measure the linkage strength among the above actors in the development should be

reviewed. Another link in this process is the reciprocal involvement of higher educational institutions. This perfect linkage may be viewed as in the following diagram (Figure 1).

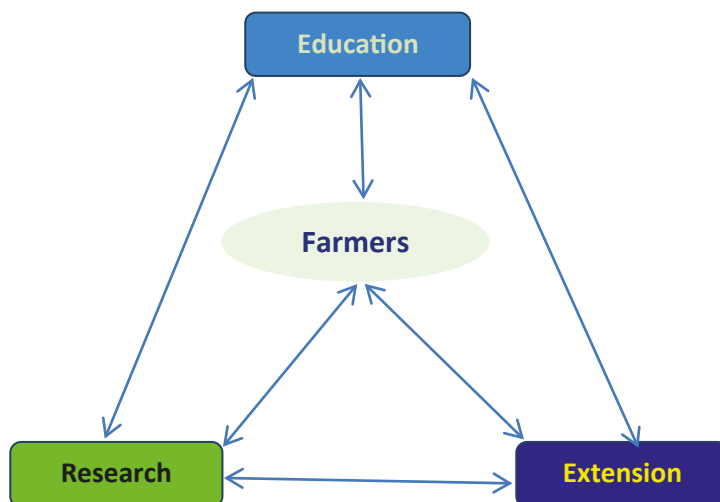


Figure 1: Linkage model of education with producer, research and extension

In regard to AIS and the above model of linkage, education should be an integral part of technology generation and extension for the betterment of productions system towards achieving sustainable agriculture and rural development. The Figure 1 clearly shows that educational institution must be an integral part of agricultural innovation systems along with all sorts of capacity development process in the field of agriculture and rural development.

But The National Agricultural Research System (NARS) could not include the Institute of Higher Education in Agriculture (IHEA) (Table 1). The major bar, as perceived apparently, is the difference of affiliation of educational institutes and research or extension establishments in two ministries. Education goes under MoE and research and extension undergo MoA. Thus, they are mutually exclusive in way of integration or to be linked formally together. In this way, as IHEA are not included in MoA, they cannot enjoy ample opportunities of using research funds provided by the ministry.

Table 1 NARS institutes and their concerned ministries

Institute	Ministry
Bangladesh Agricultural Research Institute (BARI)	Agriculture
Bangladesh Rice Research Institute (BRRI)	Agriculture
Bangladesh Jute Research Institute (BJRI)	Agriculture
Bangladesh Institute of Nuclear Agriculture (BINA)	Agriculture
Bangladesh Sugarcane Research Institute (BSRI)	Agriculture
Soil Resources Development Institute (SRDI)	Agriculture
Bangladesh Fisheries Research Institute (BFRI)	Fisheries and Livestock
Bangladesh Livestock Research Institute (BLRI)	Fisheries and Livestock
Bangladesh Forest Research Institute (BFRI)	Environment and Forest
Bangladesh Tea Research Institute (BTRI)	Commerce
Bangladesh Sericulture Research and Training Institute (BSRTI)	Jute and Textiles
Cotton Development Board (CDB)	Agriculture

Note: The institutes in white background rows are of Schedule a and the colored ones are Schedule

Regarding inclusion of higher education into extension and advisory services of national level, the IHEA are also excluded from the Agricultural Technology Extension Coordination Committee which is national apex body of extension function. The following committee (Table 2) has been formed in order to transfer new varieties and technologies at field level which are developed by institutes under Ministry of Agriculture (Notice of 14 Dec, 2017; MoA). Even the institutes are not included in regional or district committees. Thus, the IHEA cannot play their potential roles in the committees although the extension education is offered by all the institutes. The graduates who serve the extension organizations (like DAE, DoF, DLS) are produced at these institutes.

Table 2 Agricultural Technology Extension Coordination Committee (national)

Sl.	Members	Status
1.	Executive Chairman, Bangladesh Agricultural Research Council, Dhaka	Chairman
2.	Director General, Department of Agriculture Extension, Khamarbari, Dhaka	Co-Chairman
3.	Director General, Bangladesh Sugarcrop Research Institute, Iswardi, Pabna	Member
4.	Director, Soil Resources Development Institute, Dhaka	Member
5.	Director General, Agricultural Marketing Department, Khamarbari, Dhaka	Member
6.	Member-Director (Seed), Bangladesh Agricultural Development Corporation, Dhaka	Member
7.	Member-Director (Minor Irrigation), Bangladesh Agricultural Development Corporation, Dhaka	Member
8.	Director General, Bangladesh Agricultural Research Institute, Gazipur	Member
9.	Director General, Bangladesh Rice Research Institute, Gazipur	Member
10.	Director General, Bangladesh Institute of Nuclear Agricultural, Mymensingh	Member
11.	Director General, Bangladesh Jute Research Institute, Dhaka	Member
12.	Director, Agricultural Information Service, Khamarbari, Dhaka	Member
13.	Executive Director, Bangladesh Applied Nutrition Research and Training Institute, Dhaka	Member
14.	Executive Director, Cotton Development Board, Khamarbari, Dhaka	Member
15.	Executive Director, Agriculture Research Foundation, BARC Campus, Dhaka	Member
16.	Director, Technology Transfer and Monitoring Unit, BARC, Dhaka	Member
17.	Director, Seed Certification Agency, Gazipur	Member
18.	Managing Director, Hortex Foundation, Irrigation Building, Farmgate, Dhaka	Member
19.	Chairman, Bangladesh Seed Association, Dhaka	Member
20.	Chairman, Farm Implements Manufacturers' Association, Dhaka	Member
21.	Additional Director, all regions, DAE	Member
22.	Principal Seed Technologist, Seed Sub-division, Ministry of Agriculture, Dhaka	Member
23.	Director, Field Service Wing, DAE, Khamarbari, Dhaka	Member Secretary

5. The present policy in research, extension and farmer linkage

The National Agriculture Policy 2018 is the apex and comprehensive policy in the field of agriculture which was actually derived through synthesis of bundle of other sectoral previous policies. The vision of the policy is to achieve safe, profitable farming and sustainable food and nutritional security. Apart from increasing productivity in farming, the policy set a prime objective to improve research capacity through collaboration with national and international organizations.

Regarding development of research in agriculture, the policy entails *as 3.1.3 meritorious people are to be attracted to research and 3.1.5 states that quality research traditions are to be established at NARS institutes and universities, and social benefits are to be accrued through investments in research. About research planning and funding: 3.2.5 encouraged to conduct research through partnership among government/private organizations and universities.*

In respect to **technology transfer and agricultural extension**, *4.2.1 technology transfer coordination committees are to be formed at national, regional and district levels to strengthen advisory services through integration of research and extension organizations. Again, 4.4.2 tells that in case of conducting adaptive research and transfer of technologies the joint, cooperative activities of NARS institutes, extension organizations, NGOs and universities would be strengthened. Regarding training in agriculture, 7.3.1.5 states that knowledge and skill are to be developed through linkages among research, extension, educational institutes and farmers.*

Thus, the review of the policy explicates that research, extension, education and farmer linkages are envisioned to strengthen towards achieving a sustainable agricultural development. But sadly, these are not duly materialized through formation of committees and achieving actions. Even there are the committees for establishing linkages at least between research and extension is ad hoc and non-functioning. The fund for conducting joint research is allocated only through NATP and KGF but NARS excludes the universities of agriculture due to policy restrictions. Anyway, the policies should be more supportive and functional to include universities in innovation systems in agriculture. It should include agricultural universities accessing to the enormous research grants offered by MoA for sustained agricultural development.

The major policy option to bring the three actors into effective linkage is establishment of a taskforce that comprises each institution representatives to draw a policy framework that guides effective linkage. In this regard, joint problem diagnosis, joint priority setting and review meetings are in order to minimize misunderstanding and have shared vision. Specifically; Engaging the Research, Extension and Education Advisory Services and scientific community is critical to developing the new and innovative agricultural approaches required to meet successful linkages.

6. Sustainable research, extension and education linkages and the partnership

The linkage between the parts of technology generation and technology transfer in a national agricultural system often involves more than the two partners (Betru and Hamdar, 1997). Stoop (1988) indicated that the process involves such additional partners as producers, development agencies, and policy makers in different capacities working with the technology generation and transfer institutions.

The concept of linkage implies the communication and working relationship established between two or more organizations pursuing commonly shared objectives in order to have regular contact and improved productivity (Agbamu, 2000; Sadighi, 2005). The conventional argument for linkages is that by working together actors stand better chances for establishing the institutional relationships that can facilitate access to

technology, information, capital and marketing arrangements, which can in turn enable farmers to be competitive (Kimenye, 2006). For development of agriculture, an effective linkage between the research, extension and clients is the prerequisite as well as meeting the other variables of input supply, market outlet and related infrastructure (Kumar *et al.*, 2001).

Linkages are facilitated when research institutions, extension agencies and education organizations recognize the value of shared or complementary information and promote group or team approaches to problem avoiding duplication of efforts and ensuring critical tasks which do not fall through the institutional cracks. Research should start and end with the farmer (Sadighi, 2005). In Agricultural knowledge and information systems, the three major knowledge and information sources need to strive towards problem solving efforts. Linkage helps to improve resource use by linked partners are as shown in Figure 3. It presents the policy environment, which formulates the laws and incentives that influence agricultural performance; structural conditions like markets, inputs/outputs, and resource base; the governance structure that influence the system; and external influences like market, international and policy affect the pattern of linkage among REE which influenced farmers (Anandajayasekeram *et al.*, 2008). The essence of agricultural extension is to facilitate interplay and nurture synergies within a total information system involving agricultural research, agricultural education and a vast complex of information-providing businesses (Neuchatel Group, 1999).

Society offered the agricultural sector plenty of space and a high degree of self-management for agriculture. Through publicly funded research, agricultural extension and education, the MoA and MoE offered facilities to develop agricultural practices which enabled family-owned farms to make a good living. The government extension service became the connecting link, not only between farmers and researchers, but also between sector organizations and governments at various levels.

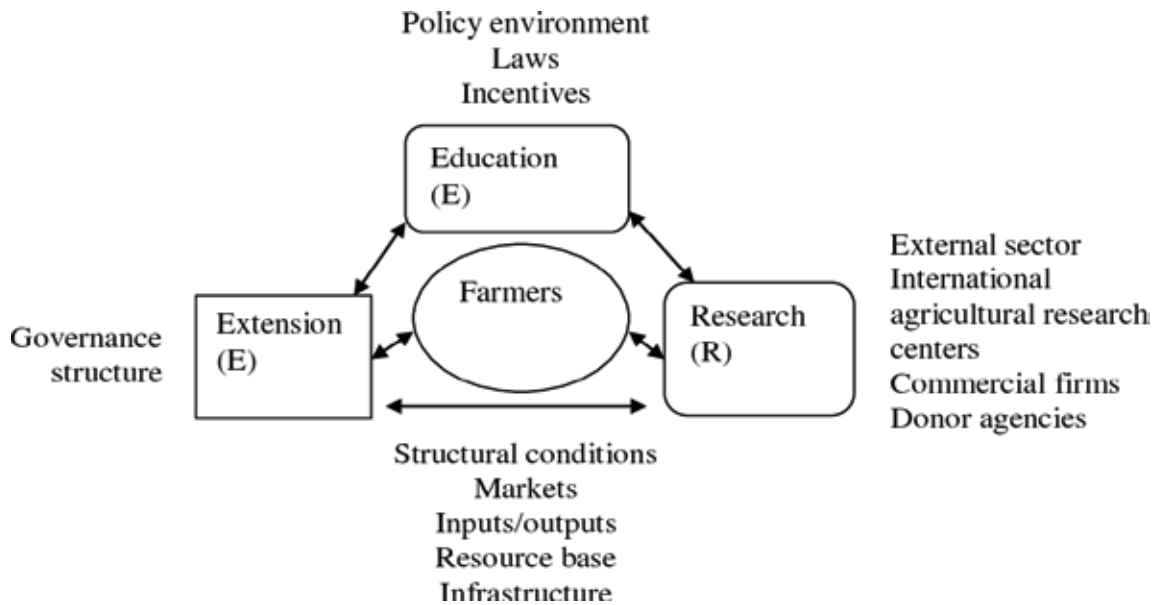


Figure 2: Research-Extension-Education linkage (adapted from Eneyew, 2013)

An ideal, effective model for linkage in general may consider the following organs (Figure 3) in technology generation and its transfer. The triangle of research-extension and education must be supported through favorable policy environment and competent entrepreneurship development process. The expected benefits of substantial linkage may lead to a sustainable agricultural development in a country like Bangladesh.

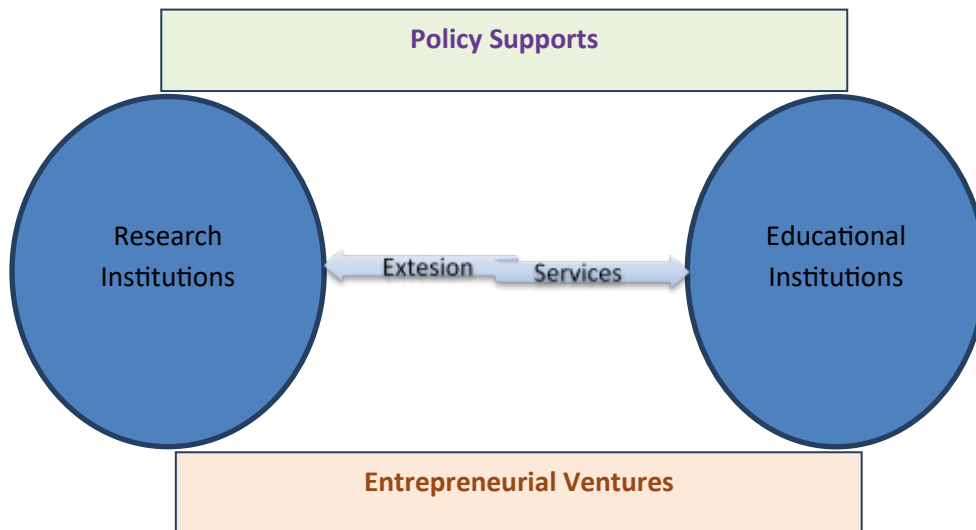


Figure 3. The Research-Extension-Education triptych with internal and external linkages (based on Wielinga et al., 2008)

7. Research and extension linkage

Developments in agricultural research have yielded high rates of return through increased agricultural productivity in many countries (Ruttan, 1982). This has encouraged large investments, often financing by borrowing from external agencies, to develop capacities for agricultural research and extension systems in developing countries. This has been done in the hope that it would increase agricultural production substantially so as to meet the needs of burgeoning populations. However, in recent years, two major concerns have been raised regarding the relative failure of research-extension services in increasing agricultural production: first, the research problems being investigated are generally not in accordance with the priority needs of agricultural producers and hence are of less relevance in addressing the prevailing problems; second, the (relevant) knowledge generated at the research stations have not been effectively transferred to the producers. Though it appears the first concern is directed towards the research extension or transfer of technology institutions, many studies have identified weaknesses in the links between research and extension institutions as the major reason for both these problems. It has been reported (USAID, 1982; FAO, 1984) that in most countries communication between public research and extension agencies is weak.

This ineffective link between research and extension "has impeded the development and transfer of technology appropriate for small-scale, resource-poor farmers, particularly those who work in relatively low-potential, heterogenous agro-ecological areas" (Ewell, 1989). Problems in technology development and transfer functions arise because these functions are treated in isolation (World Bank, 1985). According to a World Bank report (1985, pp. 79-80), "bridging the gap between research and extension is the most serious institutional problem in developing an effective research and extension system."

The ultimate objective of both research and extension systems is to increase agricultural production. Their roles of generating and transferring technology are complementary. Research institutions need to have information on the problems, technology requirements and socio-economic and ecological environment of producers to formulate research agendas and to set priorities. Formulating a research agenda based on producers' requirements results in technology that will be more acceptable to users; this also leads to research institutions allocating their resources more efficiently.

8. Recommendation and way forward

Given the state of affairs, the fundamental challenge facing the agricultural higher education sub-system in Bangladesh is to transform itself in view of adapting to the ever changing external environment. It is therefore incumbent upon the IHEA to implement curricular reform measures, adopt student-centered creative learning strategies, and introduce more practical elements into study programs so as to be able to produce graduates equipped with the knowledge, skills, values and attitudes required for promoting sustainable agricultural and rural development.

- Education Institutions should redefine so as to equip students not only with taught-subjects competency, but also with self-motivation, positive attitude, and communication skills
- Team of representatives from each institution (education, research and extension) should draw a framework that leads effective linkage such as joint problem diagnosis, joint priority setting and review meetings in order to minimize misunderstanding and have shared vision (Eneyew, 2013)
- Advisory services for sustainable agriculture should be strongly coordinated among public and private rural, agricultural extension service providing organizations of crop, livestock and fisheries by establishing National Agricultural Extension System (NAES) like that of NARS. NARS may also strengthen itself by involving agricultural extension and educational institutions in it.
- The common problems faced by the institutions of higher learning in agriculture and related fields, which need to be properly addressed if the institutions are to contribute their fair share to the agricultural development endeavor of the nation.
- In fact, in light of the many and varied challenges facing the IHEA, their response must to go beyond the traditional ways of imparting too much theoretical knowledge and produce competent and confident graduates with entrepreneurial skills and abilities to deal with the wider problems of rural development.
- Defining research priorities oriented to needs of users; creating budget line for university research; providing strong incentives for conducting research; promoting multi-disciplinary research on societal problems; allocating realistic time to research, teaching and other activities
- At the national level agricultural research and extension strategies need to recognize and define the roles of IHEA in research and extension. It is equally important that IHEA formulate their research strategic plans taking into account national agricultural research priorities and relevant local considerations.
- It is adequately perceived that policy changes, institutional reorganization, and the strengthening of organizations are required to enhance research–extension linkages in developing countries.
- Each of the research and extension organizations are competing over scarcest resources of the country towards their organization rather than cooperating with shared vision. Agricultural research institute and extension organizations are managed as separate entities and thus the prioritization of research agendas does not always closely reflect farmers ‘priorities (Feder, et al., 2010). Added to this, there is an inefficient monitoring and evaluation of the existing linkage systems.
- The education policy explicitly stated that the participation of teachers and researchers in getting the necessary field experience in various development and service institutions and professionals of such institutions in teaching will be facilitated (FDRE, 1994). The extension service has a role in helping the education specialists develop their curricula so that the students meet the needs of the industry now, and are able to adjust to the inevitable changes that will occur.
- Much of the researches conducted by academic staff and students were shelved due to either their

inappropriate contribution to real world problem or lack of linkage or ways to extend their outcomes. The way of communicating and extending university knowledge's was practiced mainly through workshops to scientific communities. There is either little attention by universities on extension of results to the wider beneficiaries or lack of visible means/linkage.

- It is accepted that the linkage among extension, research and education organizations was very low. Among the factors that challenge effective linkages , lack of policy framework, competition over recourses and inability of involving farmers in the development process, lack of effective monitoring, and shortage of incentives to strengthen both extension workers and organizations are some of the key challenges for effective linkage.
- The major policy option to bring the three actors (REE) into effective linkage is establishment of a taskforce that comprises each institution representatives to draw a policy framework guiding effective linkage. In this regard, joint problem diagnosis, joint priority setting and review meetings are in order to minimize misunderstanding and have shared vision. Specifically; engaging the Research, Extension and Education Advisory Services and scientific community is critical to developing the new and innovative agricultural approaches required to meet successful linkages.
- Agricultural universities should enhance their effort to extend scientific findings, technologies, and practices to farmers through field visits, demonstration centers, and farmers' training centers beyond workshops.
- The private sector involvement is one of the key elements to succeed in extension and advisory services delivery. Specially, efforts should be made to increase government extension system efficiency through hiving off some of agricultural services delivery to the private sector. Thus, policy framework that synergizes the relevant actors' linkage in a sustainable manner should be in place to bring the intended growth and transformation in agriculture through technology and innovation.
- Clear legislative support is needed to include IHEA in NARS, at least to limited extent. Because, the best categories of graduates retain as faculties in the universities. And, they could use the NARS opportunities to boot their research capabilities and outcomes towards developing and disseminating agricultural innovations.
- The Departments that deal with agricultural extension education of IHEA could be a part of advisory services at district or regional level. It needs policy supports.

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Recommendations on Research-Extension-Linkage and Policy Development

Five papers from NARS, DAE, DLS, DoF and University (BAU) were presented in the workshop on ‘Research- Extension-Linkage and Policy Development’ was held on 23 December 2020. There was an open discussion session followed by paper presentations. Moreover, group exercise was also organized to prepare the draft recommendations for strengthening the research-extension linkage to promote the transfer of generated technologies by NARS institutes and universities. After thread bare discussion, a draft recommendations of the workshop was made. Moreover, a consultation workshop with the experienced experts of NARS, DAE, DLS and DoF including consultants of PMU and PIU-BARC, NATP-2 was organized on 17 January 2021 at the Conference Room-1 of BARC to finalize the draft recommendations. Recommendations have also been sent to the concerned experts for their comments and their feedback has been duly accommodated in the final recommendations. The following recommendations were made for strengthening research-extension linkage of agricultural sub-sectors and transfer of project generated technologies.

A. Research-Extension Linkage for Crop Sub-Sector

1. Research issues should be identified and prioritized based on extension feedback, farmers demand, government policies and plans, SDGs targets along with market-led production systems. The Research Priority in Bangladesh: A Vision Document on Agriculture for 2030 and beyond published by BARC in 2011 need to be considered.
2. Effective research planning should be formulated for resolving specific problems indicating time frame with the participation of NARS researchers and personnel of DAE, BADC, private organizations, NGOs, universities and other relevant organizations.
3. Implementation of research programs, applied and adaptive research in particular, should be monitored by a team comprising NARS scientists, personnel of DAE, BADC, private organizations, NGOs and Universities. The observations of the monitoring team (s) should be implemented within the shortest possible time.
4. Participatory technology generation should be encouraged.
5. Technology Transfer and Monitoring Unit (TTMU), BARC as the key nodal point for technology screening and packaging of crops, fisheries and livestock should be vibrant to look into the matter that crops, fisheries and livestock extension activities function under the umbrella of BARC. Currently, Agricultural Technology Extension Coordination Committee (ATECC) headed by BARC reviews the technology transfer activities of DAE only. ATECC should be reformed so that extension activities of DoF and DLS come under ATECC. A representative from agricultural university should be included in ATECC. Operational mechanism to be identified either by BARC (TTMU) or DAE. Regular funding under GoB system should be ensured for the proposed program.
6. Each NARS institute should establish its own technology outlet/wing like OFRD, BARI as a hub of technology validation and dissemination with active participation of research, extension, farmer and private organization personnel/ representatives.

7. Technology generation and dissemination should be location specific and market oriented.
8. Breeder seeds of crop varieties should be supplied to BADC and Private Organizations for large scale multiplication.
9. Representatives from farmers of different agro ecological zones should be involved with different technology dissemination related activities to strengthen research extension linkage.
10. E-agriculture for knowledge repository and learning platform for technology dissemination is to be facilitated.
11. Public-private partnership is needed to be enhanced engaging related GOs, NGOs and Private organizations in the process of diffusion of agricultural technologies, entrepreneurship development under the leadership of BARC.
12. Existing farmers group/organizations have to be strengthened as well as new groups need to be formed through DAE for large scale pilot production and adoption of technologies, including improvement of market linkage, value chain and feedback.
13. A policy guideline should be developed for research -extension -education linkage.
14. Regional Technology Transfer workshop should be organized regularly by DAE involving NARS institutes and universities.
15. GoB fund for technology generation and dissemination should be sufficient and continuous.
16. Like National Agricultural Research System (NARS) a National Agricultural Extension Systems (NAES) has to be established for better coordination of the extension activities.

B. Research-Extension Linkage for Fisheries Sub-Sector

1. A research-extension linkage policy, strategy and action plan should be formulated to institutionalize the linkage system. Bangladesh Fisheries Research Institute (BFRI), DoF, and BFDC should jointly initiate the process immediately with the assistance of BARC.
2. Research Need Assessment (RNA) should be conducted in participatory way by BFRI, DoF, Universities and relevant organizations. BFRI should organize regional and central review workshop for research program planning.
3. Research issues should be identified and prioritized based on extension feedback, farmers demand, government policies and plans, SDG targets along with market-led production systems. Research Priority in Bangladesh: A Vision Document on Agriculture for 2030 and beyond published by BARC in 2011 need to be considered.
4. Participatory technology generation should be encouraged.
5. BFRI, DoF and TTMU, BARC should take initiative in technology screening and packaging for dissemination.

6. National Technical Committee (NTC) and Divisional Technical Committee (DTC) should be formed comprising of researchers from BFRI, Universities, DoF, NGOs and farmer's representation.
7. Technologies generated by research institutes and universities should be validated with the active participation of DoF, other extension personnel, relevant experts and farmers, and their feedback should be addressed.
8. Training of trainers (ToT) should be arranged regularly by BFRI and other concerned organizations on newly developed technologies at established training centers of BFRI and DoF.
9. Enhancement of public-private partnership engaging related GOs, NGOs and Private organizations in the process of diffusion of fisheries technologies, entrepreneurship development under the leadership of BARC.
10. Bangladesh Fisheries Research Institute (BFRI) should establish its own technology outlet/wing as a hub of technology validation and dissemination with active participation of research, extension and private organization personnel/ representatives.
11. An extension manual for strengthening research and extension linkage should be developed jointly by DoF and BFRI.
12. Regional Technology Transfer workshop should be organized by BFRI and universities.
13. A policy guideline should be developed for research -extension -education linkage.
14. Technology handbook should be published in two years interval by BFRI regularly.
15. Institutional capacity building of BFRI and DoF should be strengthened up to union level.
16. GoB fund for technology generation and dissemination should be sufficient and continuous.

C. Research Extension Linkage for Livestock Sub-Sector

1. A research-extension linkage policy, strategy and action plan should be formulated to institutionalize the linkage system. Bangladesh Livestock Research Institute (BLRI) and DLS jointly should initiate the process immediately with the assistance of BARC.
2. Program should be planned in participatory way involving BLRI, DLS, universities and other relevant organizations. BLRI should organize regional and central review for research program planning.
3. Research issues should be identified and prioritized based on the feedback from the extension agencies, farmers demand, government policies and plans, SDG targets along with market-led production systems. The "Research Priority in Bangladesh: A Vision Document on Agriculture for 2030 and beyond" published by BARC in 2011 also need to be considered.
4. Participatory technology generation should be encouraged.
5. Bangladesh Livestock Research Institute (BLRI) and TTMU, BARC should take initiative in technology screening and packaging for dissemination.

6. National Technical Committee (NTC) and Divisional Technical Committee (DTC) should be formed comprising of researchers from BLRI, Universities, DLS, NGOs private sector and farmer's representative.
7. Technologies generated by research institutes and universities should be validated with the active participation of extension personnel, relevant experts and farmers and their feedback should be addressed.
8. Training of trainers (ToT) should be arranged regularly by BLRI and other concerned organizations on newly developed technologies.
9. Public-private partnership should be enhanced engaging related GOs, NGOs and Private organizations in the process of diffusion of livestock technologies, entrepreneurship development under the leadership of BARC.
10. Bangladesh Livestock Research Institute (BLRI) should establish its own technology outlet/wing like OFRD of BARI as a hub of technology validation and dissemination with active participation of research, extension and private organization personnel/ representatives.
11. An extension manual is needed to be prepared for strengthening research and extension linkage should be developed by DLS.
12. A policy guideline should be developed for strengthening research-extension-education linkage.
13. Technology handbook should be published at regular intervals by BLRI.
14. Human resources of BLRI and DLS should be strengthened up to union level.
15. GoB fund for technology generation and dissemination should be sufficient and continuous.

D. Transfer of Technology Generated through NATP-2 or other Projects

1. Research projects of NATP-2 program and the projects from other funding sources should be administered with the core/regular research program of NARS institutes and universities.
2. Technologies generated from NATP-2 or from other projects with different funding sources should be recognized by the concerned organizations and channelized immediately for dissemination. The dissemination process should involve extension agencies, NGOs and private entrepreneurs, as appropriate.
3. Technology generated from NATP-2 or other projects funding from other sources should be disseminated through extension agencies, social, print and electronic media.
4. Allocation of sufficient fund has to be ensured by the concerned organizations for validation/ demonstration of newly developed technologies fro NATP-2 or other projects.



Inaugural Session of the National Workshop on Research Extension Linkage and Policy Development, 23 December 2020



Participants of the National Workshop on National Workshop on Research Extension Linkage and Policy Development



Dr. Muhammad Abdur Razzaque, Honorable Minister,
Ministry of Agriculture Delivering Speech as a Chief Guest



Mr. Md. Mesbahul Islam, Secretary, Ministry of Agriculture
Delivering Speech as a Special Guest



Dr. Shaikh Mohammad Bokhtiar, Executive Chairman, BARC Delivering his Speech as a Chairperson



Mr. Md. Asadullah, Director General, DAE Delivering his Speech



Mr. Md. Motiur Rahman, Project Director (Additional Secretary), NATP-2 Delivering Speech



Dr. Md. Harunur Rashid, Director, PIU-BARC, NATP-2 Delivering Speech



Dr. Md. Akkas Ali, Chief Scientific Officer, OFRD, BARI
Presenting Keynote Paper



Mr. Shamim Ahmed, Additional Deputy Director, DAE,
Presenting Policy Paper



Mr. Raju Ahmed, Assistant Director, PIU-DoF, NATP-2
Presenting Policy Paper



Mr. Faysal Mehedi Hasan, Upazilla Livestock Officer, DLS,
Presenting Policy Paper



Prof. M Zulfikar Rahman, PhD, Dept. Agricultural Extension Education, BAU, Presenting Policy Paper



Participants in Group Discussion



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