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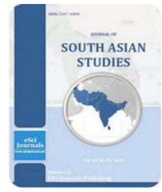


# TECHNOLOGY TRANSFER FOR FOOD SECURITY IN THE CONTEXT OF CLIMATE CHANGE: A CASE STUDY OF BANGLADESH

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## ABSTRACT

The impact of climate change is a cruel reality for Bangladesh. Recent studies show that increased temperatures, decreased rainfall, water shortage and drought as a result of climate change will reduce the food production drastically and for these reasons the number of people facing hunger and malnutrition will be increased dramatically. That is why, for the adaptation to climate change in agriculture sector, many countries throughout the world are taking initiatives. Technological transfer generally which means transfer of technical know-how is considered as a very effective adaptation policy by many scholars and International Organizations. In our country, different programs on technological transfer have been functioned since many years in the agricultural sector. But few of them are based on the impact of climate change. Those programs are successful in training farmers on line-sowing, cropping intensity, crop rotation, integrated pest management etc. But farmers do not have adequate knowledge about the stress-tolerant crops and climate-smart agricultural practices. Besides, the policy makers are not fully acquainted with the real situation at grass root level. For this reason, the policies are not always that much effective. Policies should be based on bottom-up approach where farmers' participation is important.

**Keywords:** Adaptation, Food security, Stress-tolerant, Technology Transfer.

## INTRODUCTION

Global warming and climate change are the growing issues in international affairs. Scientists throughout the world have found that there is implicit relationship between climate change and food security which is gradually being affected by the global climate changes. Bangladesh is the most vulnerable country facing the threats to climate risks (Kabir, 2005). Floods, drought and increase of salinity in coastal areas are gradually and broadly affecting agricultural productivity in Bangladesh. Nevertheless, this sector has considerable influence on overall growth of the country. Many people depend on this sector directly or indirectly through employment in small-scale rural enterprises. Since the independence of Bangladesh, it has been observed that the land and water resources are under pressure because of the overuse, degradation, and changes in resource qualities.

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The changing nature will affect availability of good quality water and species distribution, timing and length of growing season, distribution of agro-ecological zones; ecosystem stresses (erosion by water and wind, acidification, salinization, biological degradation) (FAO, 2012). Future changes in temperature, precipitation, humidity, wind, thunderstorm and hail frequency, and other climate variables could have a substantial impact on perennial crop (Agricultural commodities with life spans of two or more years) production.

We cannot underestimate the impact of climate change when over the last decades, extreme climatic events such as tropical cyclone, flood, tornado, salinity ingression, drought and aridity have dramatically affected food production across the world particularly developing countries like Bangladesh (Saferworld, 2008). That is why, adaptation to climate change is really very important for a country like Bangladesh as its economy is mostly based on agriculture. In the case of adaptation, technology transfer in agriculture has become famous all over the world.

The Bangladesh Agricultural Research Council (BARC) has designed the Agricultural Technology Transfer Project (ATTP) and The National Agricultural Research System (NARS) and universities have developed and released nearly 380 agricultural technologies for validation and transfer of profitable/commercially viable technologies. These have been shown to be commercially viable and profitable. But problems arise when it is time to implement in the farmers' fields. Farmers' participation, capacity building, entrepreneurship development and contract farming are required to ensure fair market price for the technology-based products and sustainability of the transferred technologies (Agriculture technology transfer, NFPCSP).

This article focuses on future stability of food production, technology transfer in ensuring food security, importance of social safety nets etc. in the context of climate change.

## RESEARCH METHOD AND SOURCES OF DATA

This research paper is qualitative in nature and based on both primary and secondary sources of data. The primary data is based on some questionnaire. There was in-depth interview with five households to understand different types of views on the issue. A Focused Group Discussion (FGD) was also organized with 15 farmers. The survey area was in Naogaon district. This district was chosen to see the role of technology transfer in ensuring food security in the context of climate change because there is a project on this issue which is implemented by a local NGO. The Naogaon district is under Barendra region which is affected by extreme temperature (drought prone area). Again there are limited works on drought issues in agriculture.

Secondary sources are books, reports, published research studies, case studies, newspaper articles, seminar and conference papers, BIISS journal, publication of national and international journals, magazines, documents available in the internet, government policies and plans.

Some experts' interviews were taken on this issue for providing better understanding and policy recommendations.

## DEFINING "FOOD SECURITY"

In a word it can be said that "security" means safety from any dangers. In the past, when the only term of national security was military preparedness has now been changed. Now security can be classified into two types. One is, traditional security (military aspects of security), another is non-traditional security in the form of human security (economic security, health security, food security, environmental security, personal security and political security: UNDP- 1994). In this present world non-traditional security is much more important than the traditional security.

At the national level, food security means that all citizens of a nation should have physical and economic access to the food they need, either from the market or from their own production, or through the public food distribution system. According to the article 15 (a) of the Constitution of Bangladesh, it should be a fundamental responsibility of the state to secure its citizen to the provision of basic necessities of food.

At the household level, food security means the ability of the household to secure enough food to ensure adequate dietary for all of its members at all time. To understand food security, there are two definitions: (i) "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" World Food Summit – 1996 (Saferworld, 2008). (ii) "Food security is given the topmost priority in Bangladesh. Side by side with domestic food production, greater importance is given to ensure access to adequate and safe food by all people at all times for maintaining an active and healthy life."

**Unlocking the Potential: National Strategy for Accelerated Poverty Reduction (PRSP)**

There are over 200 definitions of food security in the literature and a long history of shifts in thinking. At its meeting in Rome in October 2012, the Committee considered, but did not agree on, a new definition for food security: "food and nutrition security exists when all people at all times have physical social and economic access to food, which is safe and consumed in sufficient quantity and quality to meet their dietary needs and food preferences, and is supported by an environment of adequate sanitation, health services, and care, allowing for a healthy and active life" (Tansey, 2013).

In terms of importance food security started to be much discussed in 1970s and since then it was able to draw substantial attention. In 1979, the World Food Programme (WFP) Report conceptualized food security in terms of supply and a balanced supply-demand situation of stable foods in the international market. The report also put emphasis on increasing food production in the developing countries to enhance their food security (WFP, 1979).Nevertheless, food security would have been more meaningful if it could be perceived in line with (i) the legal commitments of the United Nations Universal Declaration of Human Rights 1948, which accepts the right to adequate standard of living, including food; (ii) International Covenant on Economic, Social and Cultural Rights 1966, which ensures an equitable distribution of world food supplies in relation to need; and (iii) the Universal Declaration on the Eradication of Hunger and Malnutrition 1974, which declares that every man, woman, and child has an absolute right to be free from hunger and malnutrition (Kabir, 2005).

According to the aforementioned definitions, four main dimensions of food security can be identified and these are in Table 1.

Table 1. Four main dimensions of food security

| Physical AVAILABILITY of food | Food availability addresses the "supply side" of food security and is determined by the level of food production, stock levels and net trade. |
|---|---|
| Economic and physical ACCESS to food | An adequate supply of food at the national or international level does not in itself guarantee household level food security. Concerns about insufficient food access have resulted in a greater policy focus on incomes, expenditure, markets and prices in achieving food security objectives. |
| Food UTILIZATION | Utilization is commonly understood as the way the body makes the most of various nutrients in the food. Sufficient energy and nutrient intake by individuals is the result of good care and feeding practices, food preparation, and diversity of the diet and intra-household distribution of food. Combined with good biological utilization of food consumed, this determines the *nutritional status of* individuals. |
| STABILITY of the other three dimensions over time | Even if your food intake is adequate today, you are still considered to be food insecure if you have inadequate access to food on a periodic basis, risking a deterioration of your nutritional status. Adverse weather conditions, political instability, or economic factors (unemployment, rising food prices) may have an impact on your food security status. |
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Source: http://www.foodsec.org/docs/concepts_guide.pdf

These dimensions are very important to understand food security. That is why, in all types of food programs these are targeted to fulfill to ensure food security. In studying food security "food system" is a term which comes frequently. In a narrow sense, a food system is a set of activities from production through to consumption. In a broader sense, a food system also includes interactions with environmental and socio-economic drivers. To simplify the term Figure 1 is provided here which shows how environmental, social, political, economic drivers affect the food system.

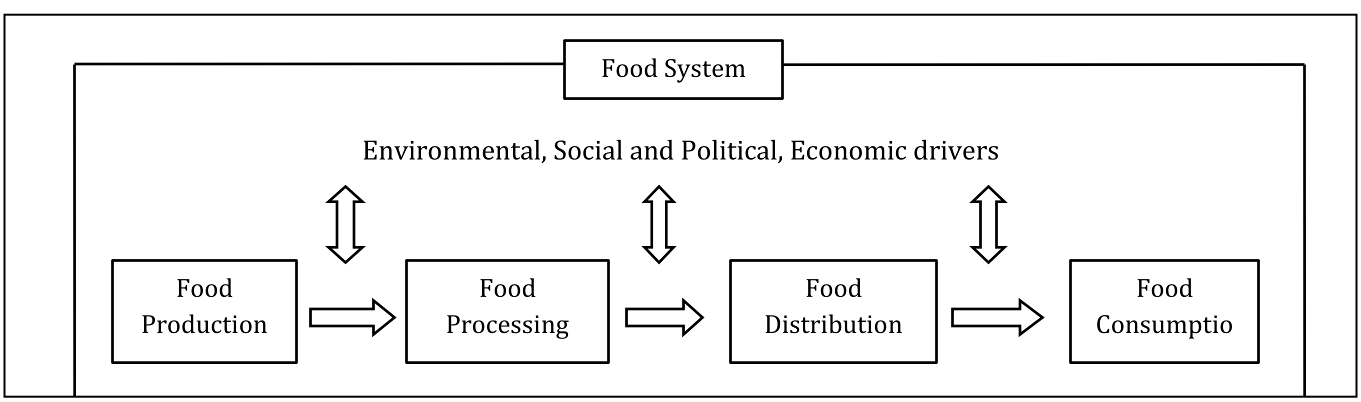


Figure 1. Food system

It is said that food security is an outcome of food system.

**UNDERSTANDING "CLIMATE CHANGE ADAPTATION"**

Climate change is a general term that refers to changes in many climatic factors (temperature and precipitation) around the world. These changes are happening at different rates and in different ways. These changes are happening at different rates and in different ways. The world mostly agrees that something needs to be done about global warming and climate change.

In 1988, the Intergovernmental Panel on Climate Change (IPCC) was created by the United Nations Environment Programme. The IPCC concluded in 1990 that there was broad international consensus that climate change was human-induced. That report led the way to an international convention for climate change--namely the United Nations Framework Convention on Climate Change (UNFCCC), signed by over 150 countries at the Rio Earth Summit in 92 [1]. (Sarkar, 2011).

The increasing nature of climate change is a reality in the present world. The majority of both natural and human systems will have to adapt to climate change in some form or the other. A broad array of adaptation strategies has been proposed for reducing the impacts of climate change in both more natural systems and human communities (Lawler, 2013). Realizing this reality, different international organizations, developed countries, policy makers etc. are now thinking about the adaptation to climate change. In this regards, it is important to understand about the term "Climate change adaptation".

According to the OECD Development Assistance Committee (DAC), adaptation is defined as activities that aim "to reduce the vulnerability of human or natural systems to the impacts of climate change-related risks, by maintaining or increasing adaptive capacity and system resilience" (OECD-DAC, 2011).

There are two types of adaptations. These are: reactive and pro-active. Reactive adaptations are those that occur after the impacts of climate have been experienced, while anticipatory adaptations are pro-active, undertaken before the impacts are fully felt. Planned adaptations are generally anticipatory, but can also be reactive (i.e., adaptations are planned to be implemented once variations in local and regional climate effects are experienced) (Swain, 2013). Bangladesh is vulnerable to any increase in occurrence of extreme climatic events. Climatic influences can result in a hindrance in development and potential changes in social and environmental conditions.

Adaptation to the adverse effects of climate change is vital in order to reduce the impacts of climate change that are happening now and increase resilience to future impacts. The UNFCCC( http://unfccc.int/ adaptation/ items/4159.php) highlights the range of issues that are being addressed by Parties under the various Convention bodies, including:

- The Cancun Adaptation Framework, which resulted from negotiations on enhanced action on adaptation and is consisted of five clusters: implementation, support, institutions, principles and stakeholder engagement;
- Nairobi work programme on impacts, vulnerability and adaptation to climate change, development and transfer of technologies, research and systematic observation under the Subsidiary Body for Scientific and Technological Advice (SBSTA);
- Issues related to National Adaptation Programmes of Action (NAPAs), and supporting adaptation through finance, technology and capacity-building under the Subsidiary Body for Implementation (SBI)

In general, intensive systems such as horticulture have greater potential to adapt, or be adapted, to changing climates than extensive and low-input systems. As an example, the assessment by Weather head et al. showed that in East Anglia, Great Britain's area of intensive field crop agriculture, water availability for crops will decrease by the 2020s, but farmers could still produce high value irrigated crops such as fresh vegetables and potatoes by reducing irrigation to other crops, installing more reservoirs to hold water from expectedly increased winter rainfall, using winter abstraction into the reservoirs and using more efficient irrigation systems such as low level dripfertigation (Dixon, 2009). But farming will be more financially vulnerable because of reduced net margins. The availability of water and nutrient resources and ability of plants to make efficient and effective use of them become crucial factors. This contention is supported by Hopkins who identifies the agricultural responses needed for adaptation to climate change as: new crops, increased irrigation and changes in land use patterns for crops and livestock.

**TECHNOLOGY TRANSFER**

"Technology transfer" has been discussed in relation to climate change mitigation for years, but the term is commonly misunderstood and difficult to apply. In simple terms, technology transfer is the diffusion of new technical equipment, practices, and development know-how from one region or company to another. The Intergovernmental Panel on Climate Change (IPCC) defines technology transfer "as a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders such as governments, private sector entities, financial institutions, non-governmental organizations (NGOs) and research/education institutions."

However, the simplicity of this description belies the complexity of its meaning. Successful technology transfer requires attention to commercial, competitive, and managerial aspects of business development, as well as ensuring the technical capability of new technologies in different locations through long-term maintenance and integration with local needs. Commonly, these different aspects are known as the hardware and software components of technology. It is now generally accepted that effective technology transfer also means creating local capacity for educating users about technology; planning sufficient transport for technology and personnel; avoiding economic dependency on subsidization; and the appropriate selection of technology for local uses and customs.

It can be seen now that different adjustments in the ecological, social, or economic systems are made in response to actual or expected stimuli and their effects or impacts. Adaptation to climate change refers to changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change. Technology transfer can play a key role in the modernization of processes. Historically, farming systems have adapted to changing economic condition, resources availability, and technology.

**Neo-liberal Institutionalism:** Among many theories of international relations, technology transfer can be explained with neo-liberal institutionalism. Neo-liberal Institutionalism mainly focused on explaining the cooperation in the field of international political economy and international environmental policy. This theory focuses on public good enlightening self-interest which includes norms, values, principles, rules, decision making procedures and expectations implicitly and explicitly in the areas of international relations which are components of International Regimes (Shamim, 2008). International regimes include formal international governmental organizations (IGOs) and regularized forms of policy coordination in a specific issue area. However, the formation and building of International Regime may benefit the global environment. The Kyoto Protocol, COPs of the UN Framework Convention on Climate Change is a good example of international regimes.

**Institutional Factors for global climate change:** There are some institutional factors expecting good prospects for an international regime to mitigate global climate change (Sprinz).

- Public and government concern for an international problem, such as global climate change
- Resources for operational and redistributive purposes e.g. technology transfer or interregional redistribution of cost
- Information provision, validation, and dissemination
- Creation of property rights
- Linkage of issues i.e. enhancing the prospects for arriving at international agreement
- Monitoring compliance with agreements
- Enforcement mechanisms including negative media attention and trade sanctions etc. International non-governmental and governmental organizations, especially the WMO, UNEP, and IPCC have been powerful in setting international agenda and provided the informal context in which national positions were formulated. In agriculture sector, there are different technologies which are adopted for the adaptation to climate change. Here, a table 2 has been provided on illustrative sustainable agriculture technologies.

**Technology Transfer for Climate Change Adaptation in the Agriculture Sector:** Agriculture has to address simultaneously three intertwined challenges: ensuring food security through increased productivity and income, adapting to climate change and contributing to climate change mitigation. However, food security and climate change can be addressed together by transforming agriculture and adopting practices that are "climate-smart" (*Climate-smart agriculture and the World Bank: The facts*. http://climatechange.worldbank.org/content/climatesmart-agriculture-and-world-bank-facts).Climate-smart agriculture aims to support food security taking into account the need for adaptation and the potential for mitigation. A number of production systems are already being used by farmers and food producers to reduce greenhouse gas emissions, adapt to climate change, and reduce vulnerability. Developing climate-smart agriculture is thus crucial to achieving future food security and climate change goals. To adapt to climate change farmers will need to broaden their crop genetic base and use new cultivars and crop varieties. They will need to adopt sustainable agronomic practices such as shift in sowing/planting dates, use of cover crop, live mulch and efficient management of irrigation and reduce the vulnerability of soil based agricultural production systems through the management of soil fertility, reduced tillage practices and management of the cycle of soil organic carbon more efficiently in grasslands and cropping systems (FAO).Climate-smart agriculture includes not only agriculture production technologies, but also involves the improvement of services supporting farmers in the transformation of their production systems, for example:

- Climate information systems;
- Extension services incorporating specific climate change awareness;
- Climate-smart agriculture (CSA) research such as breeding of resistant.

Climate-smart farming techniques would increase farm productivity and incomes, and make agriculture more resilient to climate change, while also contributing to mitigation. CSA includes proven practical techniques, such as mulching, intercropping, conservation agriculture, crop rotation, integrated crop-livestock management, agro-forestry, improved grazing, and improved water management. CSA also includes innovative practices such as better weather forecasting, drought- and flood-tolerant crops and risk insurance (Climate-smart agriculture and the World Bank: The facts.http://climatechange.worldbank.org/content/cli matesma-agriculture-and-world-bank-facts).

Table 2. Illustrative Sustainable Agriculture Technologies and Natural Resource Management Practices.

| | |
|---|---|
| Crop rotations, including grain-legume rotations | Soil fertility management |
| Agroforestry systems | Mulching |
| Intercropping and polycultures: mixed, row, strip, relay | Drip irrigation |
| Legume intercropping | Cover crops and green manures |
| Introduction of improved crop varieties | Weed management |
| Improved fallow management | Integrated pest management |
| Organic agriculture | Soil aeration |
| Hedgerows and live barriers | Contour farming |
| Alley farming | Improved drainage |
| Rainfall harvesting and storage, micro- and macro-catchments | Raised beds, raised fields |
| Zero tillage, reducedtillage, minimum tillage, deeptillage | Windbreaks |
| Improved use and efficiency of animal manures | Precision farming |
| Improved forage and grazing management | Improved agrosilvopastoral practices |
| Grass strips | Terraces |
| Trash lines | Stone and soil bunds |
| Ditches | Home gardens |
| Aquaculture and integrated crop-aquaculture systems | Seed conservation and local seed banks |
| Improved efficiency in utilization of irrigation water | Crop diversification & high-value crops |
| Complementary use of inorganic/ organic fertilizers | Altering crop density and architecture |
| System of rice intensification | |

**Source:** Buggey, T. Storyboard for Ivan's morning routine. Diagram. *Journal of Positive Behavior Interventions*, *9*(3),Summer, 2007, 151. Academic Search Premier Database. December 14, 2007.

Among various practices of climate-smart agriculture, one is Conservation agriculture (CA) which aims to achieve sustainable and profitable agriculture, increasing crop productivity through the application of and adaptation. A table 3 of CSA practices (particularly agro-forestry and crops) is provided below which shows minimal soil disturbance, permanent soil cover and crop rotation (FAO, 2012).There are different CSA practices for incorporating trees into farming systems, the crops sub-sector and their expected impacts on food security examples of CSA as well as their expected impacts on food security, adaptation (FAO, 2012).

Table 3.CSA practices and their impact on productivity and adaptation.

| | Examples of CSA practices | Impact on productivity | Impact on adaptation |
|---|---|---|---|
| Agro-forestry | Use of trees and shrubs in agricultural farming system, e.g. improved fallows growing multipurpose trees and shrubs, boundary planting, farm woodlots, plantation/crop combinations, shelterbelts, windbreaks, conservation hedges, fodder banks, life fences, trees on pasture and tree apiculture. | Improved soil fertility and moisture with benefits on overall crop productivity. Increased product diversification. | Tree and shrubs can diminish the effects of extreme weather events, prevent erosion, stabilize soils, raise infiltration rates and halt land degradation, thus reducing vulnerability. |
| | Improved land management practices, such as: reduced zero tillage, improved agronomic practices and various soil and water conservation measures. Integrated nutrient management, such as: precision farming including efficient fertilizer application based on crop and site specific nutrient balance analysis, split application, timing. Proper management of organic soils, such as: avoiding deep drainage and deep ploughing, row crops and tubers, and maintaining shallower water table. | Better plant nutrient content, increased water retention capacity and better soil structure with tangible on-site production benefit in the form of increase more reliable crop yields. | Increased system resilience and reduced vulnerability to extreme weather events. Improved soil fertility. |

Source: Climate-smart agriculture. FAO (2012).https://weblearning.ec.europa.eu/courses/1/438012/content/_103413_1/lesson.html.

**NEXUS BETWEEN "FOOD SECURITY" AND "CLIMATE CHANGE"**

Climate change is a growing concern for agriculture since agriculture and climate are interrelated. Recent studies show that increased temperatures, decreased rainfall, water shortage and drought as a result of climate change will reduce the food production drastically. As a result, the number of people facing hunger and malnutrition will be increased dramatically. Current estimates indicate that climate change could put 63 million more people at risk of hunger by 2020 (Nwanze, 2009).

Climate change refers to a broad display of alterations in climatic and weather conditions characterized by shifts in average conditions and in the frequency and severity of extreme conditions. Agriculture is highly sensitive to climate, both in terms of longer-term trends in the average conditions of rainfall and temperature, which determine the global distribution of food crops, but also in terms of inter-annual variability and the occurrence of droughts, floods, heat waves, frosts and other extreme events. One of the expected results of climate change is increasing climatic variability; for example, even where mean rainfall is not projected to change, there are likely to be more significant droughts and more significant extreme precipitation events. A changing climate is associated with increased threats to food safety, post-harvest losses and pressure from invasive species, pests and diseases.

Climate change has impact on the growth of any crops. When temperature falls below the range or exceeded the upper limit, crop production faces constraints. Higher temperature has negative effect on soil organic matter also. On the other hand Rainfall is one of the major climatic factors for crop production. All crops have critical stages when it needs water for their growth and development. Moreover, excessive rainfall may occur flooding and water logging condition that also lead to crop loss. Excessive rainfall causes flood. Flood has most deleterious effect on crop production of Bangladesh. The 1988 floods in Bangladesh, deemed "the flood of the century", covered more than two-thirds of the country and caused 2.04 million metric tons of rice crop losses (equal to 10.45 percent of target production in 1998/99) (Ninno, Dorosh, Smith & Roy, 2001). Again, higher discharge and low drainage capacity, in combination with increased backwater effects, would increase the frequency of such devastating floods under climate change scenarios. Prolonged floods would tend to delay *Aman*plantation, resulting in significant loss of potential *Aman*production, as observed during the floods of 1998. Loss of *Boro*rice crop from flash floods has become a regular phenomenon in the *Haor*areas over the recent years.

In the Southern part of Bangladesh, sea level rise causes salinity intrusion, flooding and increasing cyclone frequency and its depth of damage. Combined effects of these three factors decrease agriculture production in the coastal zone. Salinity intrusion due to sea level rise decreases agricultural production by unavailability of fresh water and soil degradation. Increasing sea level rise and river bank erosion are two most important reasons to lead the land shortage of the country. According to Ministry of Agriculture, area of total cultivable land is 8.44 million hectare(MoA, 2012).

Table 4.Bangladesh agriculture at a glance.

| Category | Amount |
|---|---|
| Total area | 14.845million hectare |
| Forest | 2.599 million hectare |
| Cultivable land | 8.44 million hectare |
| Current fellow | 0.469 million hectare |
| Single cropped area | 2.851 million hectare |
| Double cropped area | 3.984 million hectare |
| Triple cropped area | 0.974 million hectare |
| Net cropped area | 7.809 million hectare |
| Total cropped area | 13.742 million hectare |
| Total food crop demand | 23.029 million metric ton |
| Total food crop production | 27.787 million metric ton |
| Net production | 24.569 million metric ton |

Source: Ministry of Agriculture (MoA), 2012.

Improving availability and access to food are necessary but not sufficient conditions to ensure that people will be secured of food for leading an active and healthy life. In recent times there has been increasing concern over utilization of food which is governed by a number of factors such as people's food preference, general health condition and the overall environment under which food is prepared and consumed. All these factors have an impact on the absorption of food and the consequent nutritional status of people.

**Adaptation to Climate Change and Technology Transfer for Food Security:** Different technologies play vital role in adapting agricultural sector. Bangladesh made significant progress in agricultural research through improving and innovating newer varieties of crops. Moreover, government agencies made remarkable progress in innovating high yielding varieties including the Bangladesh Agriculture Research Institute (BARI), Bangladesh Rice Research Institute (BRRI), Bangladesh Institute of Nuclear Agriculture (BINA) and the Bangladesh Agricultural University (BAU). Department of Agricultural Extension (DAE) plays an important role in disseminating the newer varieties which are fit with changing climate through trial and critical evaluation in the demonstration plots. (Anik, Sawon, Kabir, & Ray, 2000)

In Bangladesh, a list of different climate tolerant varieties (salinity, flood and drought tolerant) as adaptation technologies in Agriculture (Crop-Rice) is provided in annexure 1 (The list has been collected following the interview with Dr. Abu Wali Raghib Hassan on 28 October, 2013. Project Director. Disaster and Climate Risk Management in Agriculture (DCRMA) Project. Department of Agriculture Extension. Ministry of Agriculture. Bangladesh).

The DAE in Bangladesh, with its partner research institutions like BARI and BRRI, is a farmer service-oriented institution with a long history of linking farmers with frontier technologies and innovative farm practices. Therefore it provided a good entry point for taking a lead role in connecting climate change modeling research, with communities and farmer's needs. On the other hand however, considerable structural innovations within the organization as well as skills building and attitudinal changes were required to capacitate DAE, and its national research partner institutions, for performing in close collaboration and coordination new tasks needed to (i) translate climate change modeling results into medium and long term agriculture impacts and (ii) transform these into concrete adaptation options relevant to farmers' current thinking and needs; while applying a 'language' and communication strategy which farmers can understand easily (FAO, 2007).

There is a list of a project named Disaster and Climate Risk Management in Agriculture (DCRMA) following in the Annexure 2 (The list has been collected following the interview with Md. Mizanur Rahman on 28 October, 2013. Agriculture risk management analyst. Disaster and Climate Risk Management in Agriculture (DCRMA) Project. Department of Agriculture Extension. Ministry of Agriculture. Bangladesh) which is induced by Government of People's Republic of Bangladesh. Since 1997 different programmes and projects have been implemented through Department of Agricultural Extension (DAE) in Bangladesh with the potential to improve adaptive capacity of rural livelihoods against climate risks (FAO, 2006).

**Climate change accelerates the causes of food insecurity:** Poverty is not only the reason of food insecurity in rural areas. There are some other reasons. The ultra-poor farmers who do not have their own lands they cultivate others land as share cropper. As per provision of share cropping, they get a portion of yields from the land owners. Therefore, the farmers do not need to buy the crops those cultivate as share cropping like rice, wheat or potato etc. However, the farmers fail to get proper nutrition from their crops because they grow only some selected crops that only fulfill the demands of carbohydrate. It does not meet up the needs of other nutrients.

Problems become so intensified when sudden flood and/or drought occur due climate change. As a result the agricultural fields remain without crops. By such changes, farmers are severely affected and ultimately become poorer. Therefore the dimensions of food security aren't being achieved. In these circumstances, technology transfer can play important role to grow crops and cultivate lands adapting the climate change. Most of the respondents (a) list of the respondents is provided as annexure (b) who are poor agreed that they suffer from severe food insecurity only when they witness sudden climatic disaster. All of them also agreed that the frequency of climatic disasters have been increased in recent years.

**Irrigation:** Irrigation is a very important factor to grow crops and without it farmers can hardly get good harvest. However, the required irrigation is hindered by climate change. Temperature is increasing through the unexpected changes of climate every year. Nevertheless, the layer of ground water is gradually going down. In this phenomenon, setting up deep tube-well to irrigate water from ground, scarcely benefits the farmers. The irrigation is so expensive for the poor farmers. So, they cannot get sufficient production which reduces the availability of crops. If the availability reduces at market, the price of crops increases. On the other hand, it is generally appeared that the farmers depend on agricultural activities. By selling their crops, famers can buy other essential foods which fulfill their nutritional demand. Consequently, they experience inaccessibility to food security. Again, the dependency of farmers' on the nature to produce crops is another problem. They have lack of knowledge on water management in their crop. As the climate does not remain same every year, stability of food security cannot be ensured always following the same method of irrigation.

## RESEARCH FINDINGS

**Technology transfer for nutrition security:** There are some NGOs working on technology transfer for securing nutrition of poor households at different Upazilas (sub-districts) of Naogoan district. These NGOs suggest and train the villagers about how to grow vegetables e.g. Indian spinach (green), country bean, sweet gourd, ash gourd, ridge gourd, okra, red amaranth etc. at the homestead and fallow lands. In order to cultivate these vegetables, they do not need to have lands of their own. They can also use others' fallow lands. There are different kinds of technologies transferred by these NGOs. These are as follows:

- Different types of vegetables have different cultivation practices. They train to cultivate vegetables following the proper method.
- They inform and train season-wise crop cultivation practices.
- Quality seeds are very important in agriculture production. Villagers are provided with good quality seeds and technologies to preserve them.
- Use of pesticides and chemicals are harmful to the environment as well as for human body. They train farmers to follow alternative methods for pest and disease control.
- They give proper information and knowledge about the necessity of the adaptation to climate change to grow crops and vegetables.

- They make them aware of growing nutritious food. The ultra-poor villagers are encouraged to work together at community level.

These technologies help them to fulfill their own demands of nutritious food. They do not have to depend on rice only.

**Technology Transfer for Food Security:** Increasing temperature for the changes in climate unexpectedly is now one of the rising global problems and a reality. Although Naogoan is located at Barendra area and the temperature is higher than any other places of Bangladesh. Besides, the nature of growing temperature is increasing day by day. Agricultural sectors are becoming badly affected because of the excessive temperature and sudden rainfall. It can be seen that people are commonly producing an Indian rice variety which is known as 'Swarna-5' that is a name of an Indian crop variety (rice) (http://www.thehealthsite.com/news/could-indian-swarna-rice-variety-hold-the-key-to-beating-diabetes/). This rice seeds are available and comparatively less expensive. Yet, this variety has some problems adapting to the changing climate.

- It is less stress-tolerant than the local varieties;
- Due to less adaptation capability to climate change, it cannot produce expected yields. People of this region know about different aspects of technology transfer. Some of these are: (i) Line-sowing; (ii) Number of tillers per hill; (iii) How to cultivate vegetables; (iv) Cropping intensity; (v) Crop rotation; (vi) Pest management; and (vii) Risk taking mentality.

However, there are also some other aspects which refer to the lacking of knowledge of the people. These are as followed:

- Lack of eagerness to know about the seed varieties adapting to climate change
- Shortage of knowledge on drought tolerant seeds
- Risk taking mentality
- Lack of understanding how to produce various crops with less irrigation

Different NGOs and government officials are helping them to learn about the alternative crops which are stress-tolerant. For example, sugarcane, wheat and pulse need less water than paddy. In some areas in Naogaon, farmers are growing sugarcane. There was a concept among farmers that buying rice is a symbol of poverty. But gradually, observing the changing nature of climate, they are motivated to cultivate other crops which are stress-tolerant as well. This is climate change adaptation.

**Exchange visit:** To make technology transfer effective, the government's agriculture offices organize to take farmers to another village where technology has been adopted already. In this way, they try to encourage farmers. Sometimes they arrange farmers' field day programs where they show farmers how technology transfer can help them. These efforts are made to motivate them.

## CHALLENGES OF TECHNOLOGY TRANSFER AND ADAPTATION TO CLIMATE CHANGE

There are some challenges regarding the issue for which technology transfer cannot be implemented fully. These challenges are discussed below:

- People do not have risk taking mentality. Farmers are seen to follow the conventional method of cropping (Raghib, 2013).They feel insecure to accept new technologies.
- Sometimes it takes too much time (1 or 2 years) to disseminate any new technology. In such cases, both the farmers and the concerned people lose patience. To run such program cost extra expenses. (Hossain, 2013)
- Funding is another problem in implementing technology transfer for climate change adaptation. Moreover, in conducting research on this issue, funding is a major problem.
- For the changing climate, people migrate from rural area to urban areas. It makes crisis in the rural areas when hardly people are found to take technology. Dr. Abu WaliRaghib Hassan said that sometimes they see good production in the field but having such labor problem; crops are left in the field.
- Farmers do not have proper knowledge about the stress-tolerant crops. While taking interview of 15 farmers in Naogaon district, all of them told that they buy Swarna. This variety is a stress-tolerant variety (flood) in India (IRRI, 2010). But the context is different here in Naogaon. Here draught tolerant variety is required. There are some stress-tolerant varieties in Bangladesh. But most of the time these varieties cannot reach to the farmers.
- "Shortage of man power is another problem" said by Mazharul Aziz Ph D. For this reason, ensuring quality input and policy support are not always

- possible. Both Dr. Abu Wali Raghib Hassan and Mazharul Aziz Ph D agreed that there are policy and management gaps in this sector also.
- Lack of access to information is another problem in implementing technology transfer.
- After releasing any variety by BADC, it does not reach to the field level.
- Md. Mizanur Rahman said that there are no relations between policy maker and grass-root level situation. For this reason, the policies are not always that much effective. According to him, policies should be based on bottom-up approach.
- Political dimension is important here. Sometimes political parties take such initiatives which act as obstacles for technology transfer.
- Agriculture Information Service (AIS) has duty to advertise on agricultural methods or technologies. But we cannot see any commercial ads on the issue.
- Policies are not taken thinking the gendered dimension.

**POLICY RECOMMENDATIONS**

Some policy recommendations regarding technology transfer for food security in the context of climate change are given below:

- Risk transfer mechanisms should be included in adaptation strategies from the household level to the national level. This can include crop insurance or diversified livelihoods such as integrated aquaculture–agriculture systems which allow activities to shift in response to changes in the suitability of land and availability of water to produce food.
- Community seed bank and food bank should be ensured by the local communities with the help of agricultural officers and concerned authorities.
- Strengthening the capacity building of the local communities with the help of the local NGOs in association with governmental and international cooperation.
- Habituating the adjustment of agricultural practices with the changing climate and consequently the recurrent floods, droughts and cyclones.
- Economic diversification within sectors reduces the dependency on climate-sensitive resources, particularly for countries that rely on narrow ranges of climate-sensitive economic activities (Swain, DK, Rawade & Mohanty, 2013).
- Food security and sustainable agriculture must be integrated with national and international policies considering the changing climate.
- Agricultural production based budget and investment should be enhanced and properly distributed among the climate induced impacts affected communities.
- Sustainably intensify agricultural production by changing the conventional systems for reducing greenhouse gas emissions and other negative environmental impacts of agriculture.
- Developing of specific programmes and policies to assist populations and sectors that are most vulnerable to climate changes and food insecurity should be ensured by the concerned authorities as practical as possible.
- Reducing loss and waste in food systems, targeting infrastructure, farming practices, processing, distribution and household habits.
- Public-private partnerships can be promoted in climate change adaptation. The vulnerable agricultural systems are facing huge environmental and social challenges, in view of potentially harmful effects of climate change. Corporate Social Responsibility (CSR) is a new concept in Bangladesh whereby organizations including private entrepreneurs are taking responsibility vis-à-vis the society for the impacts of their activities on communities and the environment.
- Now though DAE gets early warning from Disaster Ministry about any disaster, having inadequate technologies DAE sometimes fails to take effective measures. For example, in the time of cyclone Mahasen, Bangladesh witnessed damages in the agriculture sector. More technological and mechanical assistant should be made by the government to face such sudden disasters.
- In the rural area, government officer's are provided cycle to make visit. But it is hard to reach in remote areas riding bicycles. Like the NGO's officers, government agriculture officers should be provided bikes for their field visit.
- Commercial advertisement should be published on printing media, telecast on electronic media about the importance of climate change adaptation and necessity of new technologies.

**CONCLUSION**

Among the other fundamental rights of human being, food is considered one of the most important rights. Now- a- days, throughout the world food security along with nutrition security have become a matter of great concern. Ensuring food security means to ensure availability, accessibility, utilization and stability of food. All these dimensions of food security can be ensured by technology transfer. Using technology transfer in agriculture sector, many countries are becoming food secured. Though in our country, technology transfer in agriculture sector can be seen but most of them are not based on the context of climate change. Climate change acts as a threat multiplier which is making the challenges of sustainable food security much more difficult and making our country more vulnerable. Technology transfer in the context of climate change can ensure food security. But there are so many challenges in implementing technology transfer in the field level. Problems can be found both in the policy making level and field level. Investments are needed today for enhancing future food security. This requires action on several fronts, including tackling climate change, preserving land and conserving water, reducing the energy footprint in food systems, developing and adopting climate resilient varieties, modernizing irrigation infrastructure, shoring up domestic food supplies, reforming international food trade, and responding to other global challenges.

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**ANNEXURE 1****

Table 1.1 Adaptation Technologies in Agriculture (Crop-Rice) in Bangladesh Climate Tolerant Rice Varieties (salinity)

| Sr. | Popular tolerant Rice varieties | Crop Season | Months (seed sowing and harvesting time) | Salinity tolerant level (ds/m) | Growth Duration (days) | Average Yield (Ton/Ha) | Remarks |
|---|---|---|---|---|---|---|---|
| 1. | BR 23 | *Aman* | 1-15 July/ 25-30 October | Saline tolerant | 150 | 5.50 | Popular variety in southern region where It can be cultivate as late variety. |
| 2. | BRRI Dhan 40 | *Aman* | 1-15 July/ 25- 30 October | 8 ( medium salt tolerant) | 145 | 4.50 | - |
| 3. | BRRI Dhan 47 | *Boro* | 15-30 November / 1-15 April | 12-14 at seedling stage and 6 at elder stage | 152 | 6.00 | Land should be keep weed free up to 40 days after transplanting |
| 4. | BRRI Dhan 53 | *Aman* | 20 June – 15 July/ 30 November-15 December | 8-10 ( medium salt tolerant) | 125 | 5.00 | Suitable variety for medium low land in coastal area. It can be cultivate comparatively low land in other areas. |
| 5. | BRRI Dhan 54 | *Aman* | 20 June – 15 July/30 November-15 December | 8-10 | 135 | 5.50 | Suitable variety for medium low land in coastal area. It can be cultivate comparatively low land in other areas. |
| 6. | BRRI Dhan 55 | Boro and Aus | 15-30 November/ 10-25 April | 8-10 up to 3 weeks | 145 | 7.00 | Early variety. Moderately cold and drought tolerant. |
| 7. | BRRI Dhan 61 | Boro | 15 November -15 December/ 10 April – 10 May | 12-14 ( 3 week at seedling stage) and 8 -10 at growing stage to reproductive stages | 140-145 | 3.80-7.40 | Released in 2013 |
| 8. | Binadhan -7 | Aman | 15 June -30 July/ November-December | Saline tolerant | 110-115 | 4.50 | Moderate saline tolerant. Short duration variety |
| 9. | Binadhan -8 | *Boro and Aman ( It can also cultivate in Aus season)* | Mid November-Mid April/June-Dec/ | 12-14 ds/m at seedling stage and 8-10ds/m at mature stage. | 130-135 (in Boro) & 125-130 (Aman) | 5.00 | It is BLB, sheath blight, BPH, steam borer and rice hispa tolerant variety. Released in 2010. |
| 10. | Binadhan-10 | *Aman and Boro* | 15 June -30 July/ November-December (Aman), 1 November-15 December/ Mid April-Mid may (Boro) | Tolerate up to 12 dS/m of salinity | 127-132 days | 5-6 t/ha under salt stress (In non saline condition, potential yield is 8.5t/ha (average 7.5 t/ha). | Released in 2012. The variety possesses deep green and erect flag leaves, trunks and stems are strong, sturdy and remain erect (no loading) even in stormy weather and no shattering. Disease incidence and pest attacks are very low. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 11. | BARI gom-25 | 15November-6 December | Heat tolerant | Specially, suitable for growing well in southern region having salinity level of 8-10 dS/m at seedling stage | 102-110 | 3.60-4.60 | It also heat tolerant variety. This variety is suitable for late planting after harvesting *Ama*n rice. |

Table 1.2 Adaptation Technologies in Agriculture (Crop Rice) in Bangladesh Climate Tolerant Rice Varieties (Flood).

| Sr. | Popular tolerant Rice varieties | Crop Season | Months (seed sowing and harvesting time) | Flood tolerance days | Growth Duration (days) | Average Yield (Ton/Ha) | Remarks |
|---|---|---|---|---|---|---|---|
| 1. | BRRI dhan 28 | *Boro* | Mid December-7 January/ 1-25 May | Early variety | 140 | 5.50-6.00 | |
| 2. | BRRI dhan 46 | *Aman* | 5-10 August/ 10-15 December | | 150 | 5.00 (3 ton for late planting) | Late variety |
| 3. | BRRI dhan 51 | *Aman* | 15-30 June (in northern area) and 1-15 July in other areas)/ 25 October -30 November | 10-15 | 14—145 9 155-159 if inundate by flood) | 4.5—5.00 (4.00 -4.50if inundate) | Harvest should be done when 80% grain ripe (become golden colour from the tip of panicle). |
| 4. | BRRI dhan 52 | *Aman* | 15-30 June in northern region and 1-15 July in other areas | 12-14 | 140-145 ( 155-16 if inundate up to 14 days) | 4.00-4.50 ( if inundate) and 4.50-5.00 in normal condition | Released in 2010 |
| 5. | Binadhan-11 | *Aman* | 15 June- 30 July/ | 20-25 days submerged condition | 130-135 days (under 20-25 days submerged condition) and 115-120 days for non submerged condition | 4.20 (In submerged condition, potential yield is 4.5 t/ha ) | Binadhan-11 has been released in 2013. |
| 6. | Binadhan-12 | Aman | 15 June- 30 July | 20-25 days submerged condition | 140-145 | 3.5 t/ha. This variety is capable to produce 4.2-4.5 t/ha in non submerged condition. | Released in 2013. |

Table 1.3 Adaptation Technologies in Agriculture (Crop-Rice) in Bangladesh Climate Tolerant Rice Varieties (Drought).

| Popular tolerant Rice varieties | Crop Season | Months (seed sowing and harvesting time) | Drought tolerance | Growth Duration (days) | Average Yield (Ton/Ha) | Remarks |
|---|---|---|---|---|---|---|
| BRRI dhan 42 | Aus | 15 March-30 April/ 30 June -15 August | Drought tolerant | 100 | 3.50 | Early variety. Suitable for Kushtia, Jhinaidah, Magura, Chuadanga. It is suitable for direct sowing. Released in 2004. |
| BRRI dhan 43 | Aus | 15 March-30 April/ 30 June -15 August | Drought tolerant | 100 | 3.50 | Early variety. Suitable for Kushtia, Jhinaidah, Magura, Chuadanga. It is suitable for direct sowing. Released in 2004. |
| BRRI dhan 56 | Aman | 15-30 July/ 30 October – 5 November | In reproductive stage it can tolerate up to 10-12 days without rain. | 105-110 | 4.50-5.00 | Short duration variety. It can produce 3.50 ton even in less than 20% soil moisture. Released in 2011. |
| BRRI dhan 57 | Aman | 15-30 July/ 30 Octobr-05 November | | 100-105 | 4.50-5.00 | It can produce 3.00 ton even in less than 20% soil moisture. |

Table 1.4 Adaptation Technologies in Agriculture (Crop-others) in Bangladesh Climate Tolerant Rice Varieties (Drought)

| Popular tolerant Rice varieties | Crop Season | Months (seed sowing and harvesting time) | Drought tolerance | Growth Duration (days) | Average Yield (Ton/Ha) | Remarks |
|---|---|---|---|---|---|---|
| BARI gom-25 | - | 15 November-6 December | Heat tolerant | 102-110 | 3.60-4.60 | Saline tolerant. This variety is suitable for late planting after harvesting *Ama*n rice. |
| BARI gom-26 | | 15November-6 December | Heat tolerant | 104-110 | 3.50-4.50 | This variety is suitable for late planting after harvesting *Ama*n rice. |
| BARI triticali-1 | | 15November-6 December | Drought tolerant | 106-112 | 4.20 -4.50 grain and 10-11 ton green grass and | It is very early variety. It can produce green grass and grain. Released in 2010. |
| BARI triticali-2 | | 15November-6 December | Drought tolerant | 110-116 | 4.30- 4.60 grain and 10-12 ton green grass. | It is very early variety. Can produce green grass and grain. Released in 2010. |

| | | | | | |
|---|---|---|---|---|---|
| BARI mug 5 | Last February to mid March (Kharif-I)/ First April to mid april (Kharif-I), First August to last September (Kharif-II) / Last October to first November (Kharif-II), | Short duration crop | 60-65 | 1.20 – 1.50 | |
| BARI mug 6 | Last February to mid March (Kharif-I)/ First April to mid April (Kharif-I), First August to last September (Kharif-II) / Last October to first November (Kharif-II), Last January to mid February (Late Rabi)/ Last March to Mid February (Late rabi) | Short duration crop | 55-58 | 1.50 | This variety is suitable to cultivate after harvesting wheat to before planting T. Aman. Released in 2003. |
| BARI Chhola 3 | | | | | |
| BINA Chhola 2: | | | | | |
| BARI Keshari 3 | | | | | |
| BARI masur 3 | | | | | |
| BARI masur 4 | | | | | |
| BINA Til -1 | | | | | |
| BINA Til-2 | | | | | |

** Annexure 1 consists of Table 1.1, Table 1.2, Table 1.3 and Table 1.4. The list has been collected following the interview with Dr. Abu Wali Raghib Hassan on 28 October, 2013. Project Director. Disaster and Climate Risk Management in Agriculture (DCRMA) Project. Department of Agriculture Extension. Ministry of Agriculture. Bangladesh.

**ANNEXURE 2*****

Government of the People's Republic of Bangladesh

**Disaster and Climate Risk Management in Agriculture (DCRMA) Project**

(CDMP-II/ DAE Part)

Khamarbari, Farmgate, Dhaka-1215

**LIST OF ADAPTATION OPTIONS/TECHNOLOGY/PRACTICES OF DCRMA PROJECT**

Duration: April, 2013

| Sr. | Name of adaptation options/technology/practice |
|---|---|
| 1. | Arum cultivation in the marshland |
| 2. | Cassava cultivation |
| 3. | *Chui jhal* (*Climbing herb*) cultivation in established garden |
| 4. | Community Based Apiculture with Mustard Cultivation |
| 5. | Community based Double chambered Farm Yard Manuring (FYM) conservation |
| 6. | Community based dragon fruit cultivation |
| 7. | Community based Mushroom cultivation |
| 8. | Community based seed preservation |
| 9. | Community based vegetable cultivation |
| 10. | Community based vegetable cultivation in *gherAile* |
| 11. | Community based ground nut cultivation in char land |
| 12. | Community based year round variety (Baramashi) Drumstick cultivation |
| 13. | Cropping patter of BRRI dhan 28- green manuring |
| 14. | Cropping pattern: Boro-Dhaincha-T Aman (flood prone area) |
| 15. | Cropping pattern: Dhaincha -T Aman- Oils (Flash flood prone area) |
| 16. | Cropping pattern: Dhaincha -T Aman-Vegetables (Flash flood prone area) |
| 17. | Cropping pattern: Dhaincha-T Aman-Oils (Flash flood prone area) |
| 18. | Cropping pattern: Dhaincha-T Aman-Pulse (Flash flood prone area) |
| 19. | Cropping pattern: Dhaincha-T Aman-Pulse (Flash flood prone area) |
| 20. | Cropping pattern: Dhaincha-T Aman-Vegetables(brinjal/tomato) (Flash flood prone area) |
| 21. | Cropping pattern: T Aman-Kheshari Fallow (saline prone area) |
| 22. | Cropping pattern: T Aman-Mustard –Boro (flood prone area) |
| 23. | Cropping pattern: T aman-Mustard- vegetables(Drought prone area) |
| 24. | Cropping pattern: T aman-Mustard-Mungbean (Drought prone area) |
| 25. | Cropping pattern: T aman-Mustard-Oils (Drought prone area) |
| 26. | Cropping pattern: T Aman-Seasame – Fallow (saline prone area) |
| 27. | Cropping pattern: Wheat –Mung bean-T Aman (flood prone area) |
| 28. | Cropping pattern:T. Aman - Chick pea cultivation |
| 29. | Cultivation of green manuring crops (*dhaincha*) |
| 30. | Cultivation of potato by zero tillage method |
| 31. | Cultivation of saline tolerant rice in *Aus* season (BINA 8, BRRI dhan 47, BRRI dhan 55) |
| 32. | Cultivation of saline tolerant vegetable crops (Local brinjal*Makra*, beet) |
| 33. | Cultivation of short duration rice (BRRI dhan 55) |
| 34. | Drought tolerant crop cultivation (Hybrid maize, Wheat-BARI-25/26, cown) |
| 35. | Dry seedbed method for timely raising seedlings for T. *Aman* rice cultivation |
| 36. | Establishment of Bio-gas plant |
| 37. | Excavation of Mini Ponds for supplemental irrigation in drought prone area |
| 38. | Green manuring through *Dhaincha* cultivation |

| | |
|---|---|
| 39. | Homestead and Road side Tree Plantation |
| 40. | Improved cooking stove for household level energy efficiency and protecting women from health hazards |
| 41. | Integrated household farming (Agriculture, fisheries and livestock) |
| 42. | Inter cropping in mixed fruit garden (vegetables, turmeric, etc.) |
| 43. | Irrigation management by AWD (Alternative Wet and Dry ) method in *boro* cultivation |
| 44. | Jujube (*Apple Kul*) cultivation in saline prone and drought prone area |
| 45. | *MadrajiOll*(*Elephant foot*) cultivation in fallow land |
| 46. | Malta cultivation in saline areas |
| 47. | Mini nursery establishment |
| 48. | Mixed fruit garden (Litchi, Jujube, Guava, Mango, sapota, lemon, etc.)) |
| 49. | Mung bean cultivation (BARI -6)) |
| 50. | Potato cultivation through mulching |
| 51. | Pumpkin cultivation as relay crop with potato |
| 52. | Pumpkin cultivation by pit method in char land |
| 53. | Road side plantation of pigeon pea (*Arhar*) |
| 54. | Spices cultivation (onion, garlic, turmeric etc) |
| 55. | Use of sex pheromone in vegetable cultivation (water melon, pumpkin, cucumber, brinjal, etc.) |
| 56. | Vegetable cultivation and seedling raising in floating garden (Dhap) |
| 57. | Vegetable/tree cultivation by *Sarjan*method in the tidal flood prone area |
| 58. | Water melon cultivation (Glory and Top yield) |

*** Agriculture risk management analyst. Disaster and Climate Risk Management in Agriculture (DCRMA) Project. Department of Agriculture Extension. Ministry of Agriculture. Bangladesh.
Since 1997 different programmes and projects have been implemented through Department of Agricultural Extension (DAE) in Bangladesh with the potential to improve adaptive capacity of rural livelihoods against climate risks. The name of the project is "Disaster and Climate Risk Management in Agriculture (DCRMA)" which is induced by Government of People's Republic of Bangladesh.