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Declining Productivity of Agricultural Land in Bangladesh

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Abstract—*Bangladesh is an agricultural country with an area of 147,570 sq. km and over 50% of the total land areas are cultivated. The amount of organic matter in the soil is one of the best indicators representing soil quality. A good soil should have organic matter content. Now over 50 per cent of the agricultural land is below the critical level in Bangladesh. Practicing mono culture for a long time causes depletion of nutrients in soil and cause land degradation. Crop residues are widely used as fuel and fodder and usually not returned to the soil. Even cow dung is widely used as fuel in rural areas. Growing too many crops, year after year on the same piece of land damages the soil structure and reduces the soil fertility. Water logging for a prolonged period is responsible for decreasing of land productivity. River bank erosion is a serious cause of land loss in Bangladesh. Every year large areas along riverbanks erode mainly during the monsoons taking away good agricultural land, vegetation and human settlements. Siltation in the floodplains also contributes towards degradation of land due to flashflood and sediments accumulated from riverbank erosion. In Bangladesh, extraction of ground water has increased many folds due to rapid expansion of irrigated agriculture. Withdrawal of river water and unbridled extraction of groundwater have put the northern region at a risk of desertification through land degradation. About thirty percent of the net cultivable area is in the coastal region of the country. The severity of salinity problem in Bangladesh has increased much due to the intrusion of saline sea water. The declining productivity of Bangladesh soils mainly caused by flood, drought, salinity, high cropping intensity, use chemical fertilizers, pesticide and irrigation water without appropriate soil management practice. Upgrading land productivity with adoption of long-term land management strategy will be necessary to ensure sustaining agriculture in the country.*

Keywords: *Productivity, Agriculture, Land degradation, Impact, Bangladesh*

1. INTRODUCTION

Land degradation is deterioration of land qualities commonly caused through improper use by humans and natural disasters. Land degradation is one of the major ecological issues of the world. Land degradation means loss in the capacity of a given land to support growth of useful plants on a sustained basis [1]. Land is an important natural resource that has direct and indirect linkages with human being in every sense such as production, economic activities and social and cultural [2]. Land resources have been defined as soil resources other than minerals. In Bangladesh, soil resources mainly include yield crops, forest and pasture [3]. Land degradation is a global concern for agricultural productivity. About 70% of the total land of the world is under degradation [4]. Degradation of land is a vital issue throughout the world with the particular references to Bangladesh as it a threat to agricultural productivity. Over the last decade, crop yield has declined due to deterioration of physical and chemical properties of land and soil. Besides its social and environmental aspects, the economic implications of land degradation are tremendous [2]. Fertile soil is the fundamental resource for higher crop production; its maintenance is a prerequisite for long-term sustainable crop productivity. Soil organic matter is a key factor for sustainable soil fertility and crop productivity. Organic matter undergoes mineralization with the release of substantial quantities of N, P, and S and smaller amount of micronutrients [5].The declining productivity of Bangladesh soils is the result of depletion of organic matter caused by high cropping intensity. Degradation of physical and chemical properties of Soils with intensive cropping in the same land year after year without proper soil management practices, both physical and chemical properties of soils are liable to degradation [6]. Substantial increase in irrigated area and use of modern rice varieties have led to rapid growth of crop production in Bangladesh in the last decade. Continued and accelerated agricultural growth, which is important both for national economic growth and for poverty alleviation, will require further intensification. There is rising concern; however, that intensive agriculture may be undermining Bangladesh's natural resource base and its environment due mainly to large scale land degradation that is taking place all over Bangladesh. Land degradation leading to change in cropping and crop production is threatening the agricultural sustainability of many countries, especially developing countries with scarce land resources [7]. Farmer reports, national statistics, and the results of long-term cropping trials at BRRI all indicate that yields are stagnating and productivity is declining. These statistical data are reinforced by evidence from long-term cropping trials conducted at IRRI and elsewhere in Asia, which found persistent declines in yields

over time even under optimal management practices [8]. It is also necessary to address political, social and economic constraints globally and regionally for the sustainable management of lands. This would provide alternative livelihood opportunities, food security and certainly help to develop a sound environmental system in the developing world [9]. The paper is an overview of declining agricultural land in Bangladesh. The information out lined in this article has been collected from related published national and international document and articles.

2. LAND PRODUCTIVITY STATUS OF BANGLADESH

Soil fertility deterioration is a major constraint for higher crop production in Bangladesh. The increasing land use intensity without adequate and balanced use of chemical fertilizers and with little or no use of organic manure have caused severe fertility deterioration of our soils resulting in stagnating or even declining of crop productivity [5]. Proper nutrient management has a major influence on both yields and productivity at the farm level in the short and long term. Yield declines may occur when management practices are held constant in long-term experiments on intensive irrigated rice systems, owing to changes in soil properties as a result of intensive cropping and improper nutrient balance. It is not certain that yield declines occur or are widespread in farmers' fields because farmers continuously change management practices and adopt new technologies in response to environmental conditions and market forces [10]. The average organic matter content of top soils has decline by 20-46% over past 20 years due to intensive cropping without inclusion of legume crops, imbalance use of fertilizer, use of modern varieties and scanty use of organic manure. The beneficial effect of organic manure in crops production has been demonstrated by many workers [11-14]. Although aggregate rice yields reported at the national level continue to rise in most Asian countries, albeit at a reduced rate, yield declines have been documented in a number of long-term experiments on double-crop and triple-crop irrigated rice systems in the Philippines and India [15]. Analysis of data on yield trends at the district level shows that, despite rising input levels, yields have been declining or stagnant on about two-thirds of the area planted to modern varieties in the *boro* season in the last decade, and stagnant throughout the country in the *aman* season. Yield declines are strongly associated with the length of time that intensive production practices have been employed in each district. The results of long-term trials by the Bangladesh Rice Research Institute (BRRI) also indicate that intensive rice cultivation can result in declining yields, even under good management and with full recommended doses of all nutrients being applied [16]. The issue of land degradation is a matter of serious concern for Bangladesh, since it is a threat to crop production. Growing population pressure on land, increased human interference, intensified crop production and poor organic matter and nutrient management have led to severe land degradation problem. Decline in land qualities is very much visible in Bangladesh. Different land degradation parameters and the changes in cropping patterns over the last few decades show a close relationship with the increased intensity of land use without adoption of adequate soil conservation measures. The crop productivity in Bangladesh agriculture is declining due to inadequate and unbalanced chemical fertilizer use in increasing intensive cropping systems [17, 18]. The overall picture of rising average yields and rising production in Bangladesh has tended to camouflage evidence of declining productivity. Farmers often claim that yields have been declining and that higher fertilizer applications are necessary to maintain yields [16]. Another very important factor to consider in improving crop productivity is the soil organic matter [19]. Intensive crop production with little or no addition of manure to crop fields and inadequate fertilization resulted in decline of soil fertility, lowering of organic matter level and depletion of nutrients in soils. Organic matter content of most of the soils is as low as 1% to 1.5%, which is very low. The critical level of organic matter in soil is 2%. The addition of organic materials to soil through farmyard manure, composts, and organic residues has been reduced day by day. It is now believed that the low and declining organic matter content is one of the reasons for the low productivity of many of our soils. Thus, the need for proper soil organic matter management is essential [20]. Mono cropping patterns in the country are also responsible for the deterioration of soil quality and productivity of land due to intense use of chemical fertilizers and pesticides, and deteriorating soil quality [21]. Stagnant or declining yields in the context of rising inputs indicate that land degradation is reducing productivity; if increases in input use had not counteracted the effects of degradation, yields might have fallen even further. This evidence is consistent with patterns of yield change in other Green Revolution countries, many of which have also experienced a slowdown in the rate of growth of production and yield [16]. The international community also recognizes that Bangladesh ranks high in the list of most vulnerable countries [22]. Climate change is the **c**hanges in global temperature and precipitation patterns that are largely attributable to increasing atmospheric concentrations of carbon dioxide and other greenhouse gases. Climatic factors such as temperature, rainfall, atmospheric carbon dioxide, solar radiation etc. are closely link with agriculture production. An evaluation of the land degradation and changes in cropping pattern over the last few decades could provide a basis for future land use planning. This is emerging as an important issue regarding sustainability of the cropping pattern and productivity.

3. MAJOR CAUSES OF DECLINING PRODUCTIVITY

Depletion of organic matter, use of imbalance fertilizers, intensive crop cultivation, excessive withdrawal of

groundwater, river bank erosion, soil salinity, flood, water-logging, continuous deforestation, Shifting cultivation, climate change, lack of soil conservation management practices etc. are on-going phenomena causing serious land degradation and decreasing crop productivity situation in the country.

3.1 Declines in Soil Fertility

Decline in soil fertility is deterioration in soil physical, chemical and biological properties. It occurs through a combination of lowering of soil organic matter and loss of nutrients.

3.2 Depletion of Soil Organic Matter (OM)

A good soil should have an organic matter content of more than 3.5 per cent. But in Bangladesh, most soils have less than 1.7 percent and some soils have even less than 1 % organic matter. In Bangladesh, crop residues are widely used as fuel and fodder and usually not returned to the soil. Even cow dung is widely used as fuel in rural areas. This results in a decrease in soil organic matter content. The amount of organic matter in the soil is one of the best indicators representing soil quality. The concentration of soil organic materials in the country has been deteriorating over the last few decades. Now over 50 per cent of the agricultural land is below the critical level [6]. Decline of soil fertility occurs through and combination of lowering of soil organic matter and loss of nutrients. The average organic matter content of top soils (high land and medium high land situation) have gone under from about 2% to 1% over the last 20 years due to intensive cultivation which means and decline by 20-46% [23]. Since fertile soil is the fundamental resource for higher crop production, its maintenance is a prerequisite for long-term sustainable crop productivity. Soil organic matter is a key factor for sustainable soil fertility and crop productivity. Organic matter undergoes mineralization with the release of substantial quantities of N, P, and S and smaller amount of micronutrients [5]. In Bangladesh, depletion of soil fertility is mainly due to exploitation of land without proper replenishment of plant nutrients in soils. The problem is enhanced by intensive land use without appropriate soil management. The situation is graver in areas where high yielding varieties are being cultivated using low and unbalanced doses of mineral fertilizers with little or no organic recycling. Degradation of soil quality in the floodplains is mainly attributed to improper use of chemical fertilizers and pesticides to boost agricultural production.

3.3 Reducing availability of nutrients in soil

The areas of low fertility comprise about 60% of the total cultivable land of the country. Nutrient uptake by modern crop varieties is usually greater than that by the local varieties. Hence, in areas with increased cropping intensity coupled with the use of modern varieties, the net removal of major nutrient (NPKS) are high and ranges between 180 and 250 kg/ha/year [24]. Most of the soils under high land and medium high land situations are low in fertility level where especially N, P, K and S are deficient. Deficiencies of micro nutrients like Mg, Zn, B and Mo have also been detected in some areas [21].

3.4 Sedimentation on Agricultural Land

Another form of land degradation is deposition of sandy materials on agricultural land particularly in pediment areas of northern district. Land degradation by deposition of infertile soil on agricultural land also occurs by breach of embankment during floods. The soils eroded from the hills are usually deposited in the downstream areas. Siltation in the floodplains also contributes towards degradation of land due to flashflood and sediments accumulated from riverbank erosion [25].This phenomenon are the result of deforestation of the hills and faulty cultivation practice in the upper catchments areas. Erosion rates from most of sloping lands and even of level lands are intensive due to high rainfall.

3.5 Water logging

Bangladesh is a land of rivers and heavy monsoon rains. It is subject to inundation by over bank spills due to drainage congestion, rainfall run-off and storm-tidal surges [26, 27]. Water logging is responsible for decreasing of land productivity through rise in groundwater close to the soil surface. Water logging is also linked with salinization, brought about by incorrect irrigation management. In Bangladesh, about 0.69 million hectare has been protected from tidal surges by constructing coastal embankments. About 8000 hectares of waterlogged land in ‘Khulna’ and ‘Jessore’ district areas [25].

3.6 Soil erosion

In Bangladesh, active land degradation process is water erosion and loss of fertility due to physical, chemical or biological degradation of soils. Various kinds of soil erosion such as sheet, rill and gully erosion, landslide, bank erosion and in some cases wind erosion are occurring in Bangladesh [6]. Extensive erosion of riverbanks renders thousands of people homeless every year, and compels them to leave the affected areas in search of new settlements. It has been estimated that each year over one million people are affected by riverbank erosion [28]. The most devastating form of waterborne land degradation in Bangladesh is riverbank erosion. There are many factors that may be responsible for riverbank erosion. The unique, natural geographic setting, the behavior of an alluvial channel, together with characteristics of the tropical monsoon climate, is mainly responsible for these ravages. An enormous volume of water comes from the melting of ice in the Himalayan range. Besides natural processes, human activities both up and downstream, mainly irrational use of forest and other natural resources, cause further deterioration of the situation [29]. The whole combination of factors creates an ideal situation for producing devastating floods, which cause bank erosion and

sedimentation [2]. Accelerated soil erosion has been remarkably encountered in the hilly regions of the country which occupy about 1.7 million hectares [6].Though the loss of topsoil due to water erosion is evident in the vast floodplain areas. Faulty '*Jhum*' cultivation in hilly area causes gully erosion and losses of soil ranges from 10 to 120 t/ha/ year [30].

3.7 Salinization

Salinization is used in its broad sense, to refer to all types of soil degradation brought about by the increase of salts in the soil. As human-induced processes, these occur mainly through incorrect planning and management of irrigation schemes. Also covered in the definition is salinity intrusion, the incursion of sea water into coastal soils arising from over-extraction of groundwater and tidal flooding. In Bangladesh, salinization is one of the major natural hazards contributing towards land degradation. About thirty percent of the net cultivable area is in the coastal region of the country. The severity of salinity problem in Bangladesh increases with the desiccation of the soil. Recently, salinity both in terms of severity and extent has increased much due to the intrusion of saline sea water because of the diversion of the Ganges water in the dry season. Salinity is a problem for cropping in the dry season. But in pre-monsoon and monsoon months, salinity is no longer a limiting factor. As a result, it appears to be possible to cultivate *Aman* varieties of rice in those areas between late May and September. However, even in such cases, the expected yield reduces to a certain degree depending on the soil salinity concentration [31]. Accurate assessment of the salt affected area in the coastal region is very difficult, as the level of salinity varies according to season and year. However, it is clear from different sources that the salinity level of both surface water and soil has increased over the last decade. Saline affected areas in the coastal district have increased to about 3.05 million in 1995 from 0.83 million ha in 1966-75[31, 32].

3.8 Ground Water level

Decreasing of the water table is a self-explanatory form of land degradation, brought about through tube well pumping of groundwater for irrigation and industrial use exceeding the natural recharge capacity. In Bangladesh, extraction of ground water has increased many times due to rapid expansion of irrigated agriculture during the past three decades from 1967-1997 [6]. Withdrawal of river water and unbridled extraction of groundwater have put the northern region at a risk of desertification through land degradation [25].

3.9 Intensive and Mono crop cultivation

Growing too many crops with high chemical fertilizer and pesticides year after year on the same piece of land damages the soil structure and reduces the soil fertility. Cultivation of the same crop in the same piece of land continuously results in soil infertility. Practicing monoculture for a long time causes depletion of nutrients in soil and cause land degradation. The problem is enhanced by intensive land use without appropriate soil management. Intergrades soil fertility management forms a part of prevention; mitigation and restoration of degrade land [9]. Mono-cropping patterns in the country are also responsible for the deterioration of soil quality and productivity of land due to intense use of chemical fertilizers and pesticides, and deteriorating soil quality [21]. This is emerging as an important issue regarding sustainability of the cropping pattern and productivity [2].

3.10 Improper Use of Pesticides

Farmers of Bangladesh are using pesticides since 1957 and at present on an average of 12-15 thousand tons of pesticides are used every year. Insecticide accounts for about 90 per cent of the total consumed pesticide, and are used most for cultivating vegetables and Rabi Crops [33]. Although pesticides are used at low levels still they are a cause of land degradation. The pesticides sprayed over standing crops ultimately contaminate the surrounding soil. Research findings show that pesticides applied at the rate of about one Kilogram per hectare contaminates the topsoil to a depth of about 30 cm. The pesticides not only destroy harmful insects, but also destroy useful topsoil microbes, which eventually reduce the biological nutrient replenishment of the soil.

3.11 Improper Cultivation in Hill Slopes

Shifting cultivation on the hills, locally known as '*Jhum'*, is a common practice among the tribal communities in the greater Chittagong Hill Tracts (CHT). Traditionally '*Jhum'* cultivation is a slash-and-burn process where a certain area is cleared and cultivated. '*Jhum'* cultivation is one of the major causes of land degradation [2].

3.12 Climate change

Rice production would be major concern in recent years due to changing climatic conditions, because there is a significant amount of rice yield may hamper for only fluctuations of those climatic parameters [34]. In recent years, due to global warming, Bangladesh environment is under threat. Besides the regular disasters like drought, flooding, norwester, tornado, cyclone and tidal surge, Bangladesh is also susceptible to sea-level rise and large scale inundation of its low lying land due to global warming. The northwestern part is prone to drought mainly because of rainfall variability in the pre-monsoon and the post-monsoon periods. Since it puts severe strain on the land potential, it acts as a catalyst of land degradation through reduced soil moisture and water retention, increased soil erosion, decline in soil organic contents and overexploitation of sparse vegetation [25].These observations are particularly significant in the context of Bangladesh where agriculture is heavily dependent on temperature and rainfall patterns [35].

4. MITIGATION OF DECLINING PRODUCTIVITY

1. Proper replenishment of nutrients through balanced fertilizers and manures.
2. Recycling of organic matter through crop residues and manures to the soil.
3. Growing legumes crops as pulse or green manure crops in cropping patterns.
4. Practice conservation tillage to protect top soils.
5. Avoiding excess withdrawal of ground water for irrigation needs in dry land areas, Introducing low water requiring crop such as maize, pulses, etc. in drought prone areas of the country.
6. Emphasized the afforestation program in the country.
7. Erection of proper embankment with sluice gates in coastal areas.
8. Crop adaptation to climate change through use of recently developed crop technologies already released by BRRI, BINA and BARI in flash flood, flood, salinity and drought prone areas of the country.
9. Further development of crop varieties adaptable to climate change vulnerability.
10. Proper land use planning to optimize crop production in the country.

5. CONCLUSION

The scarcity of land and the continued growth of population, there is no alternative but to continue intensifying agriculture production in Bangladesh. Growing too many crops, year after year on the same piece of land damages the soil structure and reduces the soil fertility. Water logging for a prolonged period is responsible for decreasing of land productivity. Siltation in the floodplains also contributes towards degradation of land due to flashflood and sediments accumulated from riverbank erosion. Withdrawal of river water and unbridled extraction of groundwater have put the northern region at a risk of desertification through land degradation. The severity of salinity problem in Bangladesh has increased much due to the intrusion of saline sea water. The declining productivity of Bangladesh soils mainly caused by flood, drought, salinity, high cropping intensity, use chemical fertilizers, pesticide and irrigation water without appropriate soil management practice. Now over 50 per cent of the agricultural land is below the critical level in Bangladesh**.** Upgrading land productivity with adoption of long-term land management strategy will be necessary to ensure sustaining agriculture in the country and to undertake appropriate mitigation measures.

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