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### **Bangladesh: Integrated Farming as a Solution to Hunger and Poverty**

The predicted global crises of the future are manifest in the small, population-dense country of Bangladesh. With over one thousand people per square kilometer, Bangladesh struggles to feed its population with the relatively small amount of arable land it contains. The country's struggles will only intensify as it adds about 3 million people per year. In addition to its population crisis, Bangladesh is constantly threatened by climate change and rising sea levels. Low lying, valuable farm land is gradually being swallowed by the Bay of Bengal, leaving some farmers in abject poverty and leaving the nation with less harvest. Farmers in Bangladesh are also in danger of frequent natural disasters, which usually hit once every two or three years. These disasters can come in the form of cyclones, floods, droughts, or even rodent infestations. These disasters are especially devastating for farmers who rely wholly on one crop. For example, most farmers in Bangladesh practice rice monoculture. These farmers are dependent on the success of only one crop, and if a natural disaster ruins this crop, they have nothing else to turn to for income. The solution to the problems of overpopulation, gradually disappearing land, and natural crises lies in agricultural innovations that will produce more food on less land. However, it is essential that the farmers of Bangladesh not only increase their production, but also *vary* their production in order to increase their natural disaster resilience. Integrated farming, which combines farming crops with raising fish and livestock, is a lucrative alternative to rice monoculture. This endeavor can be undertaken with small investments, which will yield large returns. Furthermore, integrated farming is sustainable and efficient because of the interdependence among the various parts of the cycle. Integrated farming will not only alleviate food insecurity and poverty, but will also create more employment, which reduces the number of job-seekers in Bangladesh's cities (during the off-season of rice farming) and creates second-hand employment for other villagers. Integrated farming, if implemented correctly and with adequate support, will have a wide range of benefits for the rural poor of Bangladesh and for the nation as a whole.

Bangladeshi Nobel Peace Prize Laureate Muhammad Yunus has spent much of his life helping the rural poor of his country. Yunus's Grameen Bank and various development programs have slowly but surely brought about change by reducing poverty and food insecurity. Bangladesh went from 40% of people living under the poverty line in 2005 to 31.5% in 2010 ("Bangladesh Overview"). Still, there is much left to be done. Over 40% of Bangladeshis live and eat on less than \$1 a day, meaning they experience food insecurity ("Tracking"). Almost half of the nation's children experience growth retardation because of chronic malnutrition. Although education is held in high respects in most Bangladeshi families, almost half of all families cannot afford to send their children to school for more than 5 years, and thus only 51% of children manage to finish primary education ("Bangladesh Overview"). Poverty and lack of education are most common in rural families who struggle to make adequate profit from their land and crops. Natural disasters, which strike about once every two or three years, effectively take away all or most of a rural family's crops, and thus its income. When this occurs, the family is forced to reduce its food intake, pull its children out of school, and sometimes even sell its important assets. Muhammad Yunus, for example, encountered a woman in the village of Jobra who was forced to give up her biggest asset, her tin roof (Yunus). When natural disasters deepen the already deep poverty of rural farmers, women are especially affected. This is due to an "unwritten cultural law" (Yunus) that women are the first to starve if the family is food insecure. This in turn endangers the babies born to pregnant women during times of food scarcity, which contributes to the percentage of children who are underweight and malnourished (47.5%) ("Tracking"). On top of the unacceptably high percentage of malnourished children, 14% of all rural children suffer from acute malnutrition due to being chronically malnourished ("Rural"). As can be

seen, the success of the family depends on the success of the farm. Profitable and dependable farming methods, such as integrated farming, can reduce poverty and food insecurity in Bangladesh.

In order to demonstrate the benefits integrated farming can have on the people of Bangladesh, it is important to define a typical rural family. The typical family could contain three children, a mother, and a father. Universal health care is not provided by the government, and the children each have had only a few years of education (“Tracking”). The popular saying “Rice and fish make a Bengali” defines the staple foods of Bangladeshis. Accordingly, the typical farm practices rice monoculture, although a few farms grow pulses, sugarcane, mustard, and jute. Furthermore, some families raise livestock or poultry (cows, goats, ducks, or chickens), which are highly valued assets. For the rural families of Bangladesh, the major constraint on producing sufficient food is the size of the average farm (about .5 hectare), a problem that has arisen due to the high demand for arable land. Bangladesh contains only 14 million hectares of arable land, a figure that is decreasing by 1.6% annually because of erosion and construction (Karim). Furthermore, natural disasters hit frequently; the north-west suffers from droughts and river erosion, the central north is subject to serious seasonal flooding, and the southern coast is affected by soil salinity and cyclones (“Rural”). With the practices commonly used, rice monoculture oftentimes cannot provide adequate sustenance for a farm family of five. Also, on a larger scale, new methods are needed in order to provide food for the burgeoning population of Bangladesh using the available farmland.

Integrated farming is the key to producing more food on less land. This is vital in Bangladesh because each hectare of land must be used to its full potential. Currently, most rural laborers work low-income jobs with low productivity. While 44% of Bangladesh’s laborers work in the farm sector, agriculture yields only 20% of GDP (“Rural”). The basic idea behind integrated farming is that two farming practices together can symbiotically benefit each other. Farmers are not able to increase their land holdings to produce more food, so it becomes necessary to intensify food production on the arable land available. Moreover, farm integration has almost no negative environmental impact. It is impractical to worry about waste spreading from the paddy fields into the tube wells (the typical village water source). Wastes can spread into rivers, however. Fortunately, villagers seldom drink from rivers, and if they do, they are advised to use cheap water purification methods. Introducing integrated farming will bring a myriad of benefits. In one study, the introduction of integrated farming in the Mymensingh District of Bangladesh led to: increased household incomes, increased expenditure on food (and thus food security), creation of local employment, and increased ownership of livestock and poultry (Karim).

In Bangladesh, integrated farming can take many different forms to involve a combination of rice, fish, poultry, and livestock farming. The most basic and low-cost venture is rice-fish farming, in which fish are grown in the water of the paddy fields (usually 1-2 feet deep). According to a study by the Yale Macmillan Center, integration of aquaculture with agriculture is a low-cost, low-risk, sustainable economic activity that can reduce environmental degradation by obviating the need for pesticides (“Rice-Fish”). A larger investment is fish-poultry farming, in which either poultry is integrated into the existing paddy field farms, or a pond is turned into a habitat for fish which coexist with and benefit from chickens or ducks. For a farmer who has profited from these systems for several years, an even larger investment is possible: the purchase of a goat or cow. Livestock can fit in well with the already existing systems, creating a large network of farm integration (“Integrated Fish”). This network of integrated farming represents a goal for all farmers, as it is the pinnacle of food production intensification.

Integrated farming not only produces more food, but also creates more employment opportunity. Tending to fish, poultry, and livestock can provide a wide range of secondary jobs. For example, one cow alone creates an estimated 35 days of employment annually (Ramrao). Examples of the secondary jobs integrated farming can create are: poultry shelter construction, cow milking, etc. In addition to helping the villagers, additional employment opportunities will ease the rush for jobs in cities such as Dhaka that occurs during the off-season of farming.

Despite integrated farming's wide variety of benefits, there are small drawbacks. These disadvantages of integrated farming mostly arise from natural phenomena. Floods and droughts, for example, have the potential to destroy not only the rice crop, but also the fish harvest. Soil problems may affect or stunt the growth of rice, but will leave the rest of the integrated farming system untouched. Diseases and predators may be should be prepared for in order to protect livestock. The various drawbacks of integrated farming can be largely avoided if a farmer implements the full integrated farming system, thus not being independent on a single part.

Currently, average Bangladeshi farmers are not exposed to integrated farming methods. Various programs and NGOs have introduced rice-fish farming to farmers in the Mymensingh District because of the area's ideal conditions. Despite its success, the practice has not yet been employed to its full potential (Ahmed). Integration of fish, poultry, and livestock is even less common than rice-fish farming. While many farmers raise fish, poultry, and livestock, very few have integrated them in a way that reduces overall cost ("Integrated Fish"). Practicing integrated farming is a big change from rice monoculture; this is why farmers need to be convinced of integrated farming's benefits and, more importantly, familiarized with its procedures.

Although rice-fish farming is not a widespread practice, it has always been somewhat popular due to an old tradition of catching wild fish in the paddy fields. Fish dwell there because of the mostly still water (suitable for reproduction), the shade provided by the crops (regulates water temperature), and the plenitude of small organisms (insects, snails, phytoplankton, etc.) (Ahmed). The rice, which provides the fish with a habitat, benefits from the fish in return. The fish boost soil fertility by increasing nitrogen and phosphorus levels and also aerate the water. Furthermore, fish eat small organisms that can harm the rice, therefore acting as a natural pest control (Ahmed). The benefits of fish dwelling in paddy fields were demonstrated in a study that compared rice monoculture to rice-fish integrated farming. The farm that practiced the latter produced 10,178 kilograms of rice per hectare annually, while the farm that practiced rice monoculture produced only 9,691 kilograms (Ahmed). Rice-fish farming is attractive because it is not very labor intensive or costly. A rural family simply needs to introduce fish fingerlings into the paddy field habitat. This small cost will be more than repaid by the grown fish, the rice produce, and the saved cost of pesticides and fertilizer. In the rare case that there are no dikes, the farmer then needs to fence off his area or build mud dikes. Fish feed is not necessary, but rice bran, oilcakes, animal viscera, etc. will help fish growth (Ahmed). After harvest, the family will receive an income approximately 125% of its income had it only farmed rice (Ahmed). Rice-fish farming is suitable as a first step into integrated farming.

As the additional produce and income benefit the family, another investment may be feasible: the purchase of chickens or ducks. Chickens and ducks can be integrated easily into the farm for several reasons. First of all, chicken waste contains valuable undigested nutrients because chickens can only fully digest about 80% of their food ("Integrated Fish"). For example, the protein content can be as high as 30% ("Integrated Fish"). If used to fertilize the paddy fields, the fish will eat the undigested portions and the other nutrients can reenter the soil. Secondly, ducks require very little attention from the farmers because they can consume tadpoles, snails, insects, etc. Thirdly, both chickens and ducks can yield many eggs throughout the year. Even a low-producing, low maintenance duck variety can yield 70-80 eggs per year. A study in the Chhattisgarh Plains of India (similar to Bangladesh in climate and geography) reported that the net annual incomes generated by ten chickens and ten ducks were 2,350 and 3,000 Taka, respectively (Ramrao). With chicken and/or duck farming integrated with the existing farm system, the family will have additional produce and income.

The final investment for the family's farm is the purchase of livestock. A cow or goat embodies a sort of "living bank" for rural families. Livestock provides food, skin, traction, fertilizer, fuel, and insurance against crop failure ("Integrated Fish"). Livestock can be fed rice straw (byproduct of rice thrashing), grass, crop roughage, etc. The manure is often used for fuel, but can also be integrated into the paddy

fields. The farm family will have to determine whether the manure serves greater purpose as fuel or fertilizer. The leftover livestock feed can be eaten by the poultry or fed to the fish. Annually, a cow and a goat can provide a net income of 4,700 and 1,170 Taka, respectively (Ramrao). Livestock can be valuable, long-lasting assets that ensure financial security for rural families.

Another locale for integrated farming is a pond. Ponds are scattered all over the land of Bangladesh; seldom are they used to their full food-producing potential. The nongovernmental organization Danida set up the Mymensingh Aquaculture Extension Program to change this. From 1989 to 2003, MAEP has introduced pond aquaculture, where carp-sized fish are raised in ponds, to 1.4 million households. Pond aquaculture has brought these households an average of 8,283 Taka per year (145USD) (“Mymensingh”). Because the main fish feed, used by 80% of the households, was rice bran, the benefit to cost ratio was strikingly high: 27 to 1. For fourteen years, Danida invested \$2 million yearly in MAEP, and the internal rate of return on its investments was 240% (not including indirect economic impact) (“Mymensingh”).

The results of MAEP have caused the program to be heralded as one of the most successful in Bangladesh: 1) it has raised 418,000 households above the poverty threshold 2) it has improved housing, education, crisis coping abilities, and women participation in the subject households, and 3) it has caused an impressive increase in societal welfare as measured by economic surplus (“Mymensingh”). The annual fish yield in Mymensingh has risen from 1,000 kg/hectare to 3,300 kg/hectare during the years of MAEP influence. As food production and income increases for farmers, so does household nutrition. This is because households tend to sell the big fish and eat the small fish, which are rich in micronutrients that can have a huge impact on health, especially for pregnant or lactating mothers (“Integrated Fish”). MAEP has brought almost half a million households above the poverty line and at the same time increased the fish production of Bangladesh. It is a program that other development programs can learn from.

While the farmers of Bangladesh would readily adopt integrated farming because of its obvious benefits, this has not happened on a large scale yet. The main reason for this is a lack of technical knowledge. The large change from traditional rice monoculture to integrated farming cannot be easily made without planning and know-how. Even in areas with a tradition of aquaculture, farmers often fish below their full potential because of inadequate information. In one study that asked farmers what a major constraint on their practice of integrated farming was, 48% of them mentioned a lack of technical knowledge (Ahmed). Examples of useful technical knowledge are: 9-10 o'clock is the best time to manure fish ponds, silver carp will reduce harmful algal blooming, pond liming will optimize fish production, duck shelters should not have wire flooring, etc.

Another issue that will affect a farmer's decision to integrate farm systems is the availability of loans. Muhammad Yunus's Grameen Bank is already making loans available on a large scale to the rural poor of Bangladesh. Grameen Bank is providing about \$1.5 million in microloans daily, but the recipients of the microloans are almost all women (95%). Furthermore, these women have almost a 100% repayment rate, mainly because of how close the bank works with its clients (Yunus). However, the farmers who need small loans to purchase fish fingerlings, poultry, or livestock are usually men.

A program modeled after Grameen Bank ought to be set up in Bangladesh to give out microloans to rural farmers expressly for investments in the farm, particularly in integrated farming. This bank could not only work closely with the clients to insure repayment, but also *teach* the clients technical information about integrated farming. The farmers could be edified by means of booklets or by informal training. A program like this could be set up by the government, an NGO, an entrepreneur, or as an offshoot of the Grameen Bank. Such a program has very little risk because once the farmer implements the procedures correctly, a high income is almost guaranteed. A loan to buy fish fingerlings for a new rice-fish farm, for instance, can be easily repaid because the farmer earns an income that is 125% of his previous year's income. The farmer may then spread his success to his neighbors or relatives. A bank that operates like this would both provide helpful microloans and technical knowledge on integrated farming.

In order to bring about a significant change in the farming practices of Bangladeshis, the government must be involved, and, ultimately, the world. The government of Bangladesh can take heart from the results of MAEP. The program's total economic impact was over 240% of its initial investments. This bodes well for the government; future investments in integrated farming, aquaculture, etc. could more than double in economic impact. Furthermore, a Grameen-like bank that provides loans and information on integrated farming could make progress quickly at minimal cost (Grameen Bank runs with no profit). Similarly, NGOs and international organizations can take after MAEP and introduce integrated farming to parts of Bangladesh, starting with the first step: rice-fish farming. Even if Bangladeshi farmers do not introduce poultry, ducks, or livestock to their farm systems, simply farming fish in paddy fields can have a monumental effect on farm families and Bangladesh's food production.

Every day, Bangladesh has to produce more and more food to provide for its growing population. In order to remain a self-sufficient country, it will have to drastically intensify food production on the 14 million hectares of land it has available. Unfortunately, if a food shortage does occur, it will be the poor of Bangladesh, especially the rural poor, who will suffer most because they live in dense, badly constructed housing on disaster-prone land. However, these same people, the poor farmers of the countryside, have the power to avert such a crisis. Integrated farming is the key to not only feeding the nation of Bangladesh but also to empowering the rural poor and raising them above the poverty line. Integrated farming guarantees higher income, varied nutrition, more employment, and resilience to natural disaster. However, the tradition of rice monoculture cannot be changed easily; government and international cooperation is necessary. Development programs that spread information and give microloans to Bangladeshi farmers are essential. MAEP, a program that introduced aquaculture to a part of Bangladesh, is the quintessential development program; it has had tremendous economic impact and has helped Bangladesh produce 40% of its fish on only 10% of its land ("Mymensingh"). These programs must equip rural farmers with the knowledge and finances to create an integrated farm. Muhammad Yunus, whose simple and elegant vision has freed millions of Bangladeshis from the shackles of cyclic poverty, is a staunch believer in the potential of the poor. "The poor themselves can create a poverty-free world," he believes (Yunus). With the gift of knowledge about the procedures of integrated farming, the rural poor of Bangladesh will be able to, step by step, investment by investment, raise themselves out of poverty. Bangladesh has a promising future, but only if poverty and food insecurity can be taken care of. In this way, the rural poor of Bangladesh carry the nation on their shoulders. When they thrive, the nation will thrive.

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