

FDP

Fertilizer
Deep
Placement

Fertilizer Deep Placement

The global population is expected to increase from more than 7 billion today to 9.2 billion by 2050, creating enormous challenges as the world's farmers work to provide adequate quantities of nutritious food. Farmers in a number of developing countries are using fertilizer deep placement (FDP) technology to increase crop yields and incomes, reduce the amount of fertilizer used and lessen environmental damage to the atmosphere and water.

What is FDP Technology?

Working with farmers (particularly in Bangladesh) for over 20 years, IFDC developed FDP as a more effective alternative to the traditional method of applying fertilizer by surface broadcasting (spreading, usually by hand) across a field or paddy. FDP is an innovative, proven fertilizer application technology that achieves average yield increases of 18 percent while reducing fertilizer use by about one-third. Compared with broadcasting, farmers using FDP have increased incremental annual incomes by more than US \$200 per hectare (ha).¹

FDP consists of 2 key components. The first is a fertilizer 'briquette,' produced by compacting commercially available solid fertilizers. IFDC staff designed a sturdy 'briquetter,' suitable to operating conditions in developing countries. A briquetter produces 1- to 3-gram briquettes that are much larger than conventional fertilizer granules (Photographs 1-4). FDP briquettes are currently produced by more than 1,000 entrepreneurs with small-scale briquetting machines. Village-level briquetter operators sell fertilizer briquettes to farmers and fertilizer stockists. Briquettes can also be produced by commercial fertilizer manufacturing facilities.

The second key component of FDP is the placement of briquettes below the soil surface. When used to fertilize irrigated rice, briquettes are centered between 4 plants at a depth of 7-10 centimeters within 7 days after transplanting. Placement is done either by hand or with a mechanical applicator (Photographs 5-6). Thus placed, the briquette releases nitrogen (N) gradually, coinciding with the crop's requirements during the growing season.

The most widely used nitrogen fertilizer is urea, which contains 46 percent N, the highest of all solid fertilizers. While the majority of FDP activity has focused on urea briquettes to fertilize irrigated transplanted rice, blends of nitrogen, phosphorus and potassium (the 3 primary nutrients needed for optimum crop growth) have also been successfully compacted into briquettes to improve yields of rice and other crops. Micronutrients (critical to the health of plants and humans) also have been added successfully to briquettes under research conditions.

¹ Based upon 2012 prices paid by farmers for fertilizers and prices received for rice.



- ▲ 1) Prilled urea is poured into a briquetter. 2) A briquetter produces briquettes. 3) FDP briquettes. 4) The relative size of briquettes is shown.



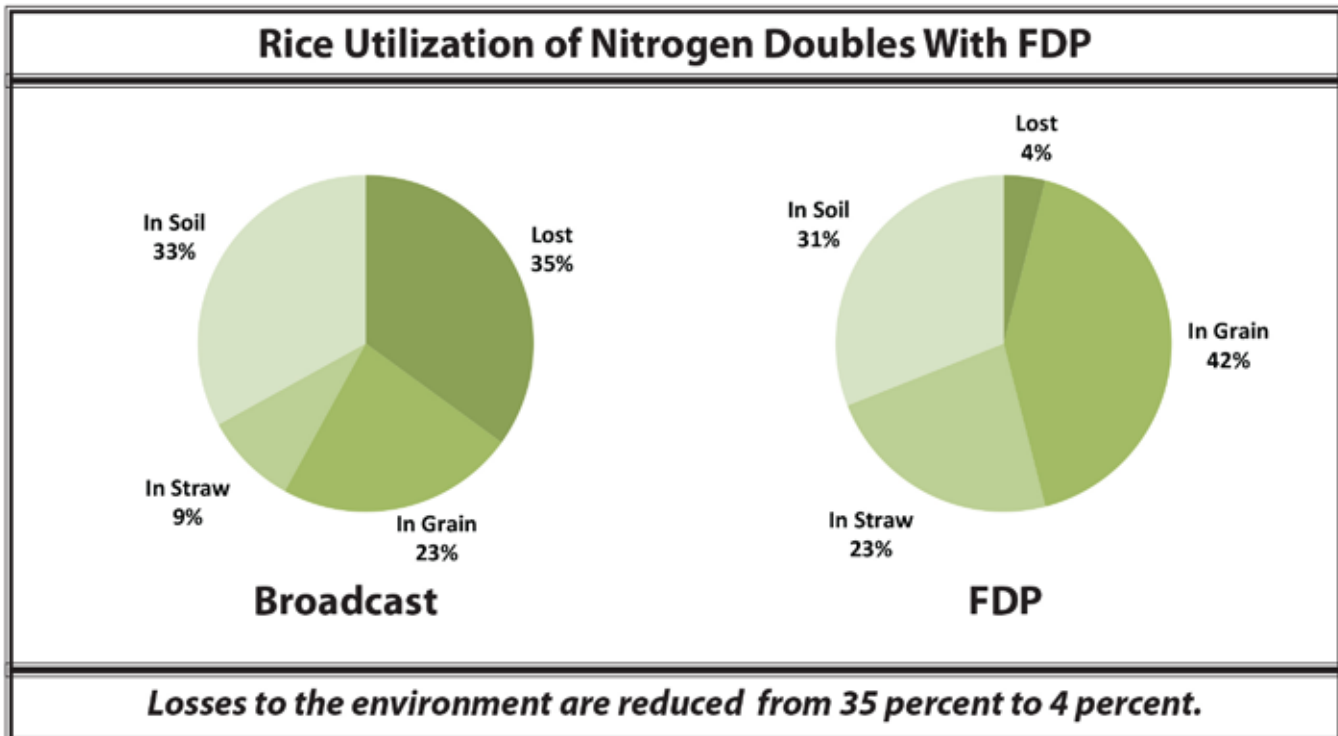
▲ 5) Farmers hand-place fertilizer briquettes in a rice paddy. 6) A farmer uses a mechanical applicator to deep-place briquettes.

How Does FDP Work?

When urea is broadcast in flooded rice fields, a large proportion of the N is wasted – lost through runoff, volatilization (atmospheric evaporation) and nitrification/denitrification. Denitrification also produces N_2O , a harmful greenhouse gas that contributes to climate change. Additional amounts of N are converted to nitrates, which are mobile in the soil and can contaminate groundwater. Nitrogen can also pollute nearby waterways if runoff/floodwater escapes a field's containment barriers.

With FDP, urea is deep-placed into the soil, where the majority remains in the form of ammonium, which is much less mobile than nitrates. As a consequence, more N is available to the crop throughout its growth cycle. Therefore, losses to the atmosphere, groundwater and waterways are drastically reduced. Only about 4 percent of the N is lost to the environment, compared with about 35 percent when N is applied via broadcasting (Figure 1). FDP dramatically improves a crop's absorption of N – two-thirds is absorbed by the rice grain and straw (post-harvest residue), compared with one-third when the broadcast application method is used (Figure 2, page 3).

Figure 1



Labor Needed for FDP

While deep-placing briquettes is more labor-intensive than broadcasting, FDP is done only once, but broadcasting urea is commonly done 2 or even 3 times per season. However, IFDC, several research institutes and private sector entrepreneurs are working to perfect mechanical applicators that will decrease the labor needed to deep-place briquettes. Fewer weeds grow when FDP is used, decreasing weeding labor and often offsetting additional application labor. Finally, IFDC research and farmer results validate that FDP technology produces higher average rice yields than broadcasting, which requires additional high-cost urea per ha. Any increased labor costs are more than compensated for by farmers' savings on fertilizer, decreased weeding costs and increased rice yields.

Benefits of FDP

- **For Farmers:** FDP decreases production costs (because an average of 33 percent less fertilizer is used), increases yield (an average of 15 to 18 percent, depending upon the crop and season), increases incomes and improves household food security. In rice cropping systems, farmers achieve additional yield increases averaging 800 kilograms (kg)/ha. While the gross margin achieved depends upon many factors (including fertilizer and crop prices), Bangladeshi rice farmers using FDP have gross margins that exceed \$200/ha.²
- **For Entrepreneurs/Dealers:** FDP provides profitable business opportunities and contributes to local economic development. In Bangladesh, net returns to dealers who manufacture briquettes average about \$1 per 50-kg bag, or about \$20/metric ton (mt). In the first year of operation, most achieve sales of more than 60 mt.
- **For the National Economy:** FDP increases rural employment and crop production, decreases fertilizer use (and, therefore, the cost of government fertilizer subsidies where they are used), increases food security, reduces rice imports and increases the gross domestic product.
- **For the Environment:** FDP reduces N volatilization and emissions of harmful greenhouse gases, as well as groundwater and waterway contamination. Because FDP doubles N utilization, the fuel required to produce urea is decreased by 50 percent, also reducing greenhouse gases.

² Annual incomes in Bangladesh average \$848.

Rice: The Essential Food for Nearly Half the World

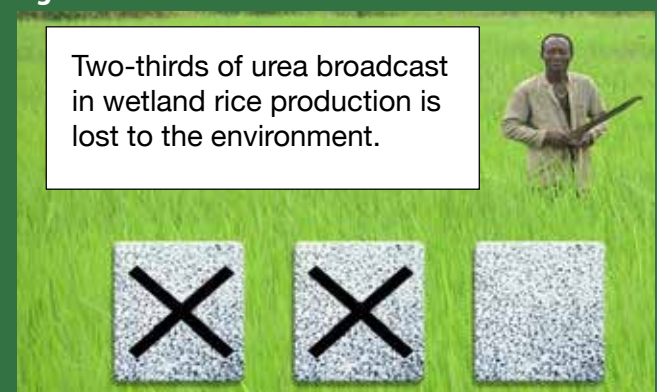
Rice is *the* staple food crop for more than 3 billion people and is cultivated in over 100 countries on 6 continents. Rice provides employment for over 1 billion people in southern and southeastern Asia, as well as in other developing regions of the world. Farmers who also consume their rice harvests constitute the bulk of the world's population that lives in poverty. More than 90 percent of all rice is grown in Asia, where half of the global population and 80 percent of the world's poor are concentrated.

China, India and Indonesia grow the most rice. Much smaller Bangladesh is the world's fourth-largest rice producer; farmers there produced nearly 32 million metric tons (mmt) in 2010 on 11.36 million ha. In contrast, Sub-Saharan Africa – with a land area of 23.6 million square kilometers (nearly 200 times larger than Bangladesh) produced only 21.5 mmt of rice on 10 million ha in 2010. Nonetheless, African rice production has risen 31 percent in the past 10 years. In fact, rice has become the second most important cereal crop in Sub-Saharan Africa.

FDP and Rice Production

- Increases yields by 15-18 percent compared with fertilizer broadcasting.
- Reduces urea expenditures by about one-third.
- Improves grain quality, which may generate higher market prices.
- Ensures nitrogen availability throughout the growing season, resulting in fewer applications of fertilizer.
- Decreases N losses from volatilization, nitrification and denitrification (greenhouse gas emissions) and nitrogen contamination of floodwater runoff.
- Encourages better water management and line transplanting. Thus, weeding is easier and less labor-intensive. The cost of hired weeding labor is reduced by 25-35 percent.
- Rice straw contains more nitrogen and therefore is a better livestock feed.

Figure 2



The deep placement of urea briquettes has helped transform 627,000 hectares of land...leading to the first-ever rice surplus in Bangladesh's poorest state, home to more than 2.2 million people. The innovation is as simple as it is effective. Instead of applying urea, a nitrogen fertilizer, to the soil – where as much as 70 percent is lost to runoff or the atmosphere – it is compacted into briquettes and buried near plant roots, where it releases nitrogen slowly.

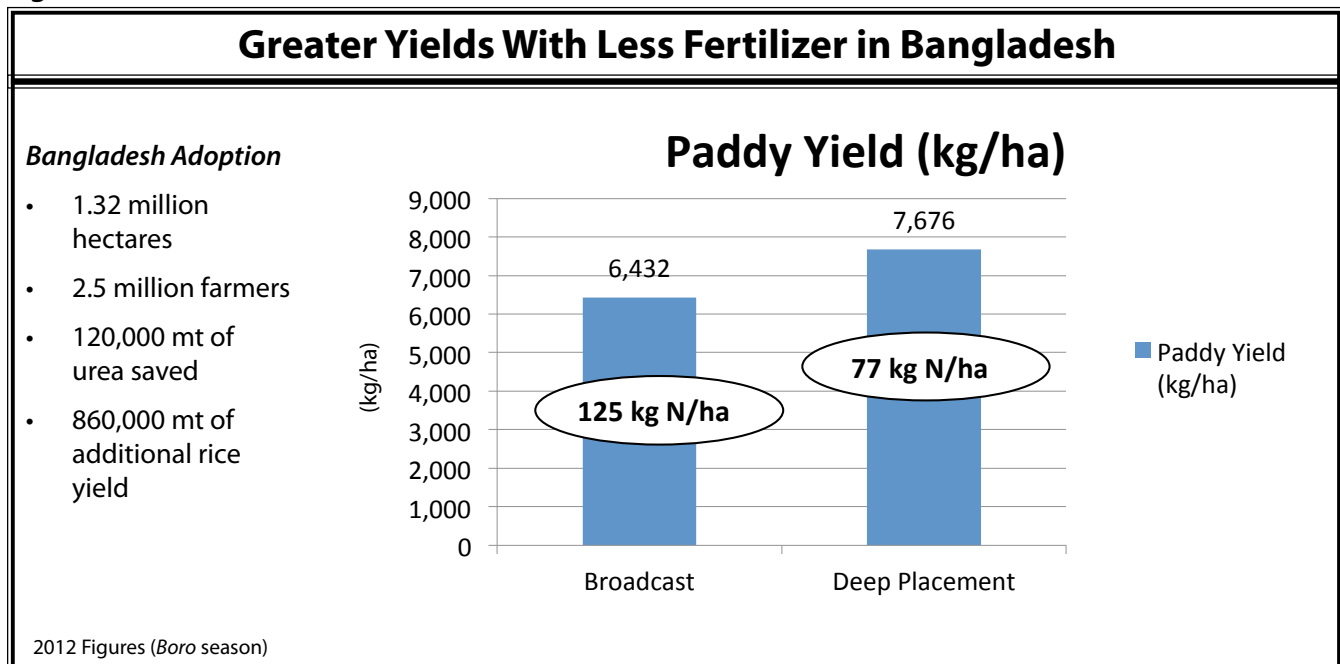
– USAID Administrator Rajiv Shah at the 2012 World Food Conference

Benefits for Bangladesh

Working with its local and national partners, IFDC introduced FDP and other improved agricultural management practices in Bangladesh in the mid-1980s, generating significant agronomic, economic and environmental benefits. Currently, more than 2.5 million Bangladeshi farmers are using FDP (Figure 3), and its use is being expanded to an additional 1 million farmers across the country.

FDP has helped Bangladesh improve food security as well. With 2 crops per year, FDP provides an additional 4.9 persons with their annual rice needs per ha. In 2012, the increased value of rice was \$176.22 million, the value of incremental sales was \$48.69 million and the Government of Bangladesh saved more than \$29 million in fertilizer purchases and subsidies.

Figure 3



Into Africa: FDP Brings Hope for Dramatically Increased Yields

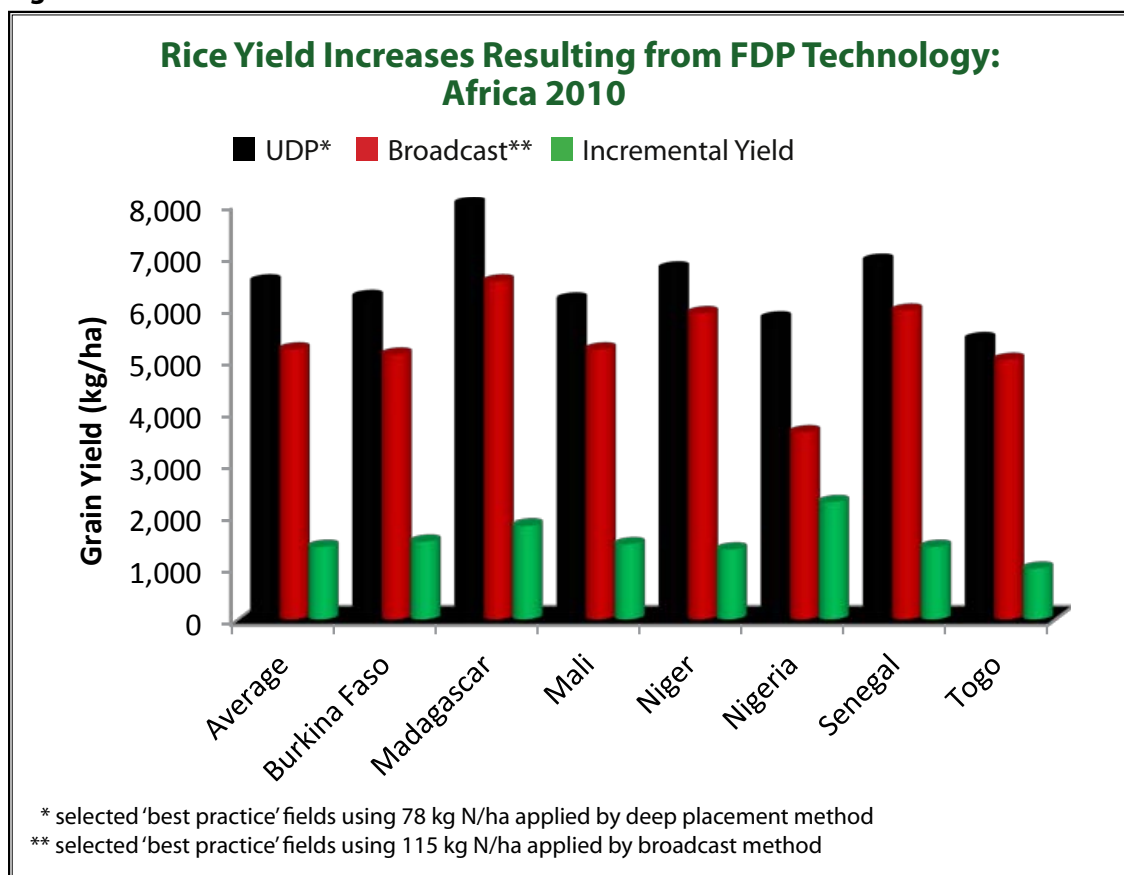
The African continent ranks eighth in global paddy rice production (with the majority grown in West Africa). Rice has become the staple food for millions of Africans and is a major part of the diets of many others. However, even though African production has increased at an annual rate of 6 percent, Africa remains a net importer of rice. Domestically grown supplies simply have been inadequate to keep pace with rising demand.

Population pressure on Africa's arable land forces smallholder farmers to farm on marginal lands with infertile soil and to use cultivated land more intensively. Intensive farming is beneficial, but because fertilizer prices are much higher in Africa than the rest of the world, mineral fertilizer use is low and soil nutrients are being depleted. Consequently, yields are well below their potential and food production has not matched population growth in many African countries, resulting in chronic food insecurity.

IFDC began its African FDP initiative in 2009, targeting 13 countries across the continent (Figure 4). The objective is to use a market-driven approach to significantly increase rice yields through the use of FDP, hybrid rice varieties and improved water management practices. Initial results indicate increased net incomes for smallholder farmers, a reduced need for costly fertilizers and imported rice and decreased environmental damage.

To date, Burkina Faso, Niger and Nigeria have generated the best results. As in Bangladesh, FDP's advantages are proven. Rice yields with FDP (compared with broadcasting) average 30 percent more (an additional 1.2 mt/ha). In double cropping systems (2 rice crops per year), farmers are realizing about \$400 in additional annual income per ha than farmers using traditional practices.

Figure 4



Moving forward, FDP is anticipated to generate the following benefits in Sub-Saharan Africa:

- Irrigated rice yields will increase from the current average of 2.1 mt/ha (farmer practice) to 6-7 mt/ha.
- Fertilizer efficiency in irrigated rice will increase from the current average of about 30 percent to 50-60 percent.
- Incomes of participating resource-poor rice farmers will increase as much as 25 percent.
- Local entrepreneurs will invest in and profit from the production and sale of FDP briquettes.



FDP Use in Other Crops

While FDP has been used most widely on rice, initial field trials indicate that the technology is well-suited to vegetable and cereal crops (including sorghum, maize and wheat) that are dependent on N for full growth, as well as other crops such as sunflowers. In Bangladesh, 15-20 percent increases in maize yields have been achieved with FDP, while farmers use 15-20 percent less N. FDP's viability is being evaluated in wheat production in Ethiopia, and farmers and researchers in a number of countries are using FDP to grow vegetables and other high-value crops.

Because FDP briquettes have a consistent weight, smallholder farmers can provide relatively precise amounts of primary nutrients according to crop demand. FDP also has the potential to address secondary and micronutrient deficiencies, now recognized as a serious yield constraint (and human health issue). Additional nutrient incorporation into briquettes could further improve the economic and health benefits of fertilizer investments.

IFDC is conducting extensive research to validate FDP's agronomic performance and economic returns in various cropping systems. Ongoing collaboration with national agricultural research organizations is also a staple of FDP testing and validation. IFDC's links with Ministries of Agriculture have helped to efficiently and effectively navigate the public sector legal framework that applies to fertilizers.

The Next Steps for FDP

FDP is a field-tested technology that increases crop yields, uses less fertilizer and decreases environmental damage. While the progress made to date is encouraging (particularly in Bangladesh with irrigated transplanted rice), the potential for FDP expansion remains immense. Research by IFDC and other organizations is underway to evaluate FDP's potential on a variety of crops, and the technology is being used and evaluated in about 20 countries in Asia, Latin America and Africa.



▲ Farmers in Nangarhar Province of Afghanistan use FDP on vegetable crops.



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