

## **Opportunities and challenges of subsurface fertilizer application in specialty crops in Bangladesh**

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Subsurface application of fertilizer (commonly called fertilizer deep placement 'FDP') in lowland rice cultivation has been widely recognized as an effective management practice that reduces fertilizer (urea) use by 25-40% and increases yield by an average of 15-20%. With significant reduction in fertilizer use, FDP increases farm profitability and reduces government subsidy payments in countries where N fertilizer subsidies exist. It is widely used in Bangladesh and some African countries, particularly in rice cultivation.

Research conducted across different countries demonstrated that FDP is an efficient fertilizer management technology that increases grain yields and offers sustainable soil fertility solutions for lowland rice cultivation. However, the long-term effects of FDP in upland cropping systems – and particularly in speciality crops - are not yet clear. This is important in the context of increasing crop diversification in rice-based cropping systems by using high value specialty crops including vegetables, fruits, and cash crops. Decreasing economic returns from rice due to increased labour shortages and reduced water availability - and in some cases grain price fluctuation and land fragmentation - are among the drivers for the crop diversification in Asian countries. Diversification to specialized crops in formerly flooded rice-based cropping systems poses a challenge to maintaining soil fertility and crop productivity. Therefore, there is a need for efficient nutrient management solutions to maximize the benefits of crop diversification, and FDP use in specialized crops could be one method to achieve these efficiency improvements.

In addition to rice and maize, deep placement of urea or multi-nutrient fertilizer briquettes containing NPK has also been tested in different vegetables and fruits in Bangladesh, comparing results to farmers' practice. Since many farmers do not practice balanced fertilization, deep placement of multi-nutrient fertilizer briquettes offers the potential for higher yields and improves fertilizer use efficiency through the balanced use of nutrients and reduced nutrient losses. In these trials, FDP increased vegetable and fruit yields by

10-20% while using 10% less fertilizers. Farmers report that deep placement improved the quality of fruits and vegetables (colour, shape), and these practices were found to significantly increase net economic returns. Farmers now use deep placement in several specialty crops, including eggplant, cabbage, cauliflower, potato, tomato, taro, bitter gourd, cucumber, papaya, guava, and watermelon. Relatedly, research conducted by Bangladesh Agriculture Research Institute (BARI) showed that FDP increased Betal leaf (*Piper beetle*) yields by 15% with 10% less fertilizers, while evidence supports similar results from the use of FDP in sugarcane.

In addition to yields, nutrient use efficiency and the environmental impacts of subsurface fertilizer placement, we will also discuss the challenges and opportunities of larger-scale adoption of FDP. In Bangladesh, where FDP technology is widely disseminated, the majority of farmers are small land holders (<2 ha). Therefore, FDP technology is being disseminated by the Government of Bangladesh in partnership with IFDC by developing micro-enterprise briquette producers, and applied manually in fields. Each local entrepreneur who owns a briquetting machine – many of whom are fertilizer dealers - produces fertilizer briquettes amounting to approximately 1 mt per day. Farmers access fertilizer briquettes through retailers' networks. This approach is effective in small scale farming where household labour is sufficient for cultivation, but requires modification to work in larger scale farming systems where labour availability is an issue, where supply chain and mechanization dynamics are different, or where national (rather than localized) results are desired. Due to the increasing trend of labour outmigration, the availability of labour has become one of the major issues of FDP adoption. Therefore, for large scale dissemination of this technology for speciality crop production in various countries, government and/or private sector actors must work together to promote wide-scale adoption by farmers through industrial-level briquette production and mechanized on-farm deep-placement solutions.