Increased rice production with less fertiliser

Efficient fertiliser management integrated with other appropriate agronomic and pest management practices is needed to improve and sustain productivity on millions of small paddy fields in Asia and Africa. Scientists of the International Fertilizer Development Center developed an Integrated Nutrient Management System to help increase and sustain rice productivity of small paddy fields in less-favourable rainfed areas. The method has the potential to increase yield levels up to 4,500 kg/ha with 40% less fertiliser use while protecting the environment.

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Small-scale resource-poor farmers in developing countries cannot afford expensive agrochemicals such as fertilisers. Conventional methods of N-fertiliser use are highly inefficient and there are no appropriate integrated technologies. Taking a holistic approach and working with national agricultural research systems (NARS) and non-governmental organisations (NGOs) in four districts of Maharashtra State, India, we developed an Integrated Nutrient Management System (INMS). INMS can be defined as a crop cultivation system that integrates efficient use of soil and applied organic and inorganic nutrients with appropriately modified agronomic and pest management practices to increase and sustain crop productivity while protecting the environment over a long time. An agrotechnology based on an INMS has been developed essentially for small-scale resource-poor rice farmers of the warm subhumid to humid tropical region on the west coast of India. The system however is flexible with minor changes to suit the local agroclimatic conditions of a region and socioeconomic constraints of farmers and with field testing for one to two seasons it can be used in other similar ecoregions. The agrotechnology is based on the use of low-cost on-farm resources as well as efficient use of N- and P-fertilisers at substantially reduced level.

Nutrient recycling

Rice needs an adequate supply of silicon for healthy growth. Farmers can use blackish-grey rice hull ash as a source of silicon for rice. It is applied to the seedbed (0.5 kg/m^2) before sowing of rice seeds. The seedlings treated with rice hull ash are healthier than untreated ones, and their use can reduce the incidence of leaf blast at seedling stage and stem borer after transplanting. This practice has two practical implications. First, the use of rice hull ash could provide an incentive for using rice hull-fired stoves for domestic cooking. The use of such stoves would benefit farm women by decreasing the need to collect firewood and it would also help to save existing forests in rice-growing regions. Second, by decreasing the incidence of stem borer and leaf blast without the use of chemical pesticides this practice would also help to protect the environment.

Small rice farmers need not buy expensive potassic fertiliser. Instead they can basally incorporate limited rice straw (2t/ha) as a source of K for a balanced NPK supply and also to recycle plant silica. The limited amount is suggested because farmers also use rice straw for other purposes, such as for cattlefeed and in making houseroofs. The use of limited rice straw has no adverse effect on the crop growth. By using smaller quantities, it is possible to reduce proportionately the labour required for spreading and to minimize CH_4 emission due to added straw. Moreover, use of limited rice straw will also promote biological nitrogen fixation in the soil.

Gliricidia leaf manuring

The use of organic manuring integrated with application of fertilisers is essential for any sustainable crop production system. Farmers can use an old agroforestry approach of growing Gliricidia (biological nitrogen fixing trees) on bunds or hedges nearby non-cultivable land and within 2-3 years after planting trees using green leaf biomass for green manuring at the rate of 2-3 t/ha. The limited green manuring practice can be affordable because it eliminates the need for expensive seed input every year. It does not require crop land and does not interfere with the main cropping season. Further the limited amount (2t/ha) requires proportionately less labour for spreading and incorporation. Growing perennial trees offers other agroforestry benefits such as providing some protein-rich green fodder supplement for cattle and some firewood as well as promoting soil conservation especially in humid ecological regions.

The primary objective of limited green manuring is not to provide a substitute for applied N but to effectively complement deep point placement of urea (the practice described elsewhere in this article). This complementary effect is important for ensuring the efficiency of the deep-place urea-N. The use of limited green manure every year can help build up soil productivity over a long time.

Bamboo transplanting guide

Unless small farmers maintain optimum plant population and use fertilisers efficiently they will not receive adequate benefits simply by using high-yielding varieties (HYVs). Farmers were using a long piece of bamboo for line transplanting. We mod-

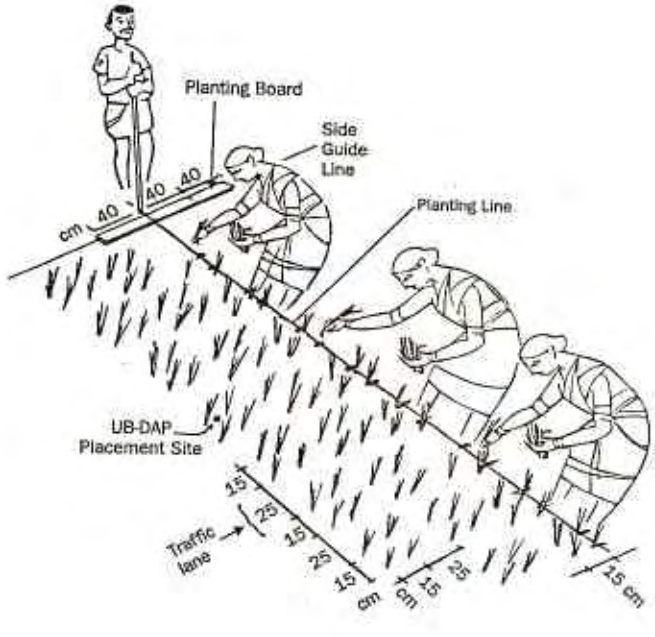

Figure 1. Using bamboo transplanting guide two workers plant two rows at a time. They then move 40 cm backward, pull the guide and align it approximately to complete transplanting the field.

ified the farmer's marking on the bamboo used and introduced transplanting of two lines simultaneously (Figure 1). This inexpensive bamboo guide is so simple to construct that in a farm demonstration a Filipino farmer fabricated it in less than one hour on his own farm. Also, it is simple to use. During the IFDC/NGO demonstration trials conducted in 1993 on 26 tribal rice farmers' fields, it was observed that more than 50% of the participating farmers preferred to transplant in line using the bamboo guide over the use of the conventional line transplanting method (Daftardar and Savant, 1995). Without hiring additional labour a small farmer having two or three family members can transplant in line to achieve the optimum plant population required by HYV and the modified spacing (geometry) required for efficient use of NP-fertilisers.

Using the bamboo guide offers farmers other benefits. The transplanting guide method integrated with efficient NP management can decrease expensive seed input as much as 60% (Daftardar and Savant, 1995). Seed saving can lower seedling requirements (up to 36%) and thus translate into substantial saving in other inputs required for seedling preparation uprooting and even transplanting. The additional labour required for the line transplanting with the guide decreases with more practice. Women farmers seem to adapt easily to using the guide. Special training for women farmers should enhance its use.

Solving constraints

In spite of the demonstrated agronomic merit of deep point placement of urea as urea briquettes (UB) it has not benefited small farmers. Through collaborative field research, we reasonably resolved the following two constraints that were hindering its use by rice farmers:

- The non-availability of proper UB material - a portable small-scale fertiliser briquetter was developed for producing UB or UB fortified with P as diammonium phosphate (UB-DAP) at the village level. This production scheme can effectively provide UB fertilizer to farmers in a given region and create a few rural jobs.
- An additional labour requirement (8-10 workdays/ha) for the UB placement by hand. We developed the bamboo guide for line transplanting with modified 20 x 20 cm spacing and 25 hills/m². The modified spacing provides traffic lanes (a non-cash input) that allow UB placement immediately after transplanting (Figure 2) and the puddled soft soil condition offers minimum resistance to inserting UB, thus making the placement easier for the workers. More important, the use of modified spacings helps to increase the speed of placement and thereby reduces the additional labour requirement as much as 50% (Daftardar and Savant, 1995).

Table 1. Average rice yields for the single deep place of UB-DAP after transplanting (improved management) split-application of prilled urea + basal application of single superphosphate (conventional practice), and farmers' traditional practice (Daftardar and Savant, 1995)

Practice	Yield* (t/ha) Grain	Straw
Integrated	**4.55**	**6.67**
Conventional	**2.99**	**4.54**
Traditional	**2.41**	**4.14**

* Average yields of 26 farmer-managed field trials (1993) with application rates of 56 kg N/ha and 14 kg P/ha

The improved NP management practice can be summarised as "one single deep placement of the correct weight UB or UB-DAP by hand at 7-10 cm soil depth (one briquette/4 hills) immediately after transplanting with the modified 20 x 20 cm spacing. The results of the collaborative trials conducted during 1990-93 on farmers' fields clearly demonstrate that the management is adoptable and has the following main benefits:

- It is simple and practical. Field experience indicates that more women labour is needed because they are mainly involved in transplanting and UB placement.
- It is agronomically efficient and less risky. It has the potential to substantially increase grain and straw yields (see Table 1).
- It is economically attractive. Rice farmers using this management can expect gross profit of five times (or more) the additional cost of extra labour required and fertiliser used. The savings in seed inputs and seedling preparation make it more attractive.
- It is environmentally friendly. It has the potential to virtually eliminate runoff and ammonia losses, thus protecting the environment. Secondly it has the potential to substantially increase yield levels up to 4,500 kg/ha at 40% less fertiliser use.

Farmers' reactions

The results of the field evaluation of the practices of INMS are promising; especially tribal farmers' responses in India to the improved fertiliser management are encouraging. When asked, more than half of the 26 participating farmers in the 1993 trials mentioned striking increases in the number of total and productive tillers/hill, and marked improvement in the development of panicles with the improved fertiliser use. Because of the increased rice productivity with less fertiliser, all the farmers except two indicated willingness to use UB-DAP fertilizer although it would cost 15%-20% more than conventional fertilisers. Therefore, the transfer of UB use agrotechnology to small-scale resource-poor rice farmers in less-endowed rainfed lowland regions of developing countries has merit. ■

Figure 2. A worker uses a traffic lane of modified 20 x 20 cm spacing for walking during the UB placement and can easily identify the placement sites (smaller 15 x 15 cm squares)

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Reference
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