Soil fertility management in

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Mahaweli System-C is an agricultural settlement scheme in the 'dry' zone of Sri Lanka. Prior to 1980 most of the land in this region was covered by forest. Between 1980 and 1990 almost 70,000 hectares of this forest was cleared to make way for an irrigated agricultural settlement of some 22,000 farmer families. Each family was provided with one hectare of irrigable rice land and 0.1 hectare of 'highland' for use as a homestead. Since rice is the staple diet of the Sri Lankan people, and with an ample supply of irrigation water assured for growing two crops of rice on the same land each year, rice monoculture tends to be standard practice for most farmers in Mahaweli System-C.

During the first three to four years (six to eight seasons) of cultivation, the new, high-yielding rice varieties spawned by the Green Revolution performed exceptionally well and yielded between five to six tonnes of rice per hectare without any fertiliser. Thereafter, rice yields began to fall drastically and farmers were compelled to apply inorganic fertilisers to maintain yields at around four and half to five tonnes per hectare. As the price of imported inorganic fertiliser increased, the profitability of rice farming began to decline. And when the Sri Lankan Government, yielding to pressure from the World Bank, removed the subsidy on fertilisers, rice farmers found themselves in dire straits.

Sesbania rostrata produces modules capable of N-fixation on its stem.

Nutrient mining

One of the important reasons for yield decline in irrigated rice is nutrient mining. Total nutrient removal per hectare by a rice crop of five tons amounts to about 100 kg of N, 16 kg of P and 128 kg of K. Farmers compensate this loss by applying about 375 kg of inorganic fertilisers which contribute 117 kg N, 23 kg of P and 42 kg of K.

Traditionally most farmers burn their rice straw on the threshing floor and do not return the ashes to the fields. Thus, whilst the grain is consumed as food, the straw is wasted by burning. The net result being the nutrient mining of the soil. Little wonder then that rice yields fall in the absence of adequate nutrient replenishment. As rice straw (5000 kg/ha) contains approximately 36 kg N, 4.5 kg P and 112 kg K, recycling straw might be a good way of balancing the negative nutrient balance.

Farmer education

Extensionists employed by Sri Lanka's Mahaweli Authority began to educate farmers by confronting them with the hard facts of conventional rice farming practices. Farmers were quick to recognise the value of incorporating rice straw into their fields during preparatory tillage rather than burning it on the threshing floor. However, many of them experienced practical problems when trying to incorporate rice straw into their fields. Some complained that the straw became entangled in the mould board plough. Others maintained that rice seedlings began to yellow shortly after the straw had been incorporated. Extensionists sought the assistance of researchers in trying to solve these practical problems.

Before long, farmers, extensionists and researchers were fully involved in many on-farm experiments designed to find the most practical way of incorporating rice straw into the field whilst minimising the negative impact on rice seedling growth. In less than two seasons of trial and error suitable solutions were found.

Incorporation of straw feasible

Farmer experimentation revealed that rice straw could be effectively ploughed back into the field if the following steps were taken :

- Spreading the straw out in small heaps (weighing 4-5 kg) spaced 2 to 2.5 meters apart over the entire rice field shortly after threshing.
- Impounding enough water in the field to allow the heaps of straw to become thoroughly wet.
- Ploughing the field with a mould board plough (first ploughing) taking care to avoid the heaps of straw and then spreading the straw uniformly over the field.*
- Cross-ploughing two weeks after the first ploughing. The straw breaks down readily into smaller pieces at this stage enabling it to be incorporated into the soil.
- Puddling, levelling and broadcasting pre-germinated rice seed about three weeks later.

Researchers were quick to point out that the yellowing of rice seedlings observed by farmers was a result of the temporary immobilisation of soil nitrogen by soil bacteria because rice had been sown broadcast immediately after the straw had been incorporated. These negative effects could be avoided if rice was sown at least three weeks after the straw had been incorporated or by applying about 20 kg of urea fertiliser per hectare of rice field when the straw was ploughed in.

irrigated rice fields

Dingiri Banda claims that ploughing in Sesbania improves the fertility of his land.

Benefits of straw application

Farmers reported the following benefits from applying straw to their rice fields:

- Healthy, robust rice plants which are more resistant to insect pest and disease attacks.
- Potassium fertiliser no longer required (rice straw is rich in potassium).
- Slightly less nitrogen fertiliser required (20-25 kg per hectare).
- Yield increases of around 400-500 kg per hectare of rice after three to four consecutive seasons of straw application.
- Improved water retention of soil.

Despite the many benefits and considerable saving of hard cash made possible by straw application, the high nitrogen requirements of better yielding, improved rice varieties still make heavy demands on inorganic nitrogen fertilisers which are mostly in the form of urea. Acutely aware of the problem faced by rice farmers who had to find the money to buy the 60-80 kg of nitrogen fertiliser (130-175 kg of urea) needed for each hectare of rice field, researchers at the Department of Agriculture's Regional Research Station in Girandurukotte, Mahaweli System-C, began looking for cheaper sources of nitrogen in the form of green manures.

Green manures

Cyril Bandara, the main researcher at the Agricultural Department's Regional Research Station in Girandurukotte, began screening a number of leguminous green manure crops such as *Sesbania rostrata, Sesbania sesban, Sesbania aculeata, Crotalaria juncea and Crotalaria caricia* for bio-mass production and N-content. *Sesbania rostrata* proved to be most promising. Research showed that at a seedling density of 60 plants per square meter, *S. rostrata* was capable of providing 4000 kg of dry matter and 100 kg of nitrogen per hectare in just 45 days of growth. Unlike most other legumes, *S. rostrata* was also unique in that it produced nodules capable of N-fixation on its stem (Photo 1).This remarkable plant from Senegal was also able to grow well in water logged soil unlike the many species of *Crotalaria*.

Sesbania rostra fits the system

Research also showed that *Sesbania rostrata* could be grown in situ in a rice field, and that it could be easily fitted into the turn-around period of the rice-rice cropping pattern of the region. The best time for ploughing in *Sesbania rostrata* proved to be 40-50 days after germination. Thus, it was possible to grow *S. rostrata* in a rice field during the 'fallow period' following one rice crop and the beginning of another (second) crop. *S. rostrata*'s potential as a green manure crop for rice was considerable. It was now necessary to introduce it to rice farmers, to determine its performance in farmers' fields and find out whether farmers would accept it.

A firm believer – but no seeds

Dingiri Banda is a rice farmer in the Divulapelessa Unit of Mahaweli System-C. He is an innovative farmer always looking for new things to try out. He applied straw routinely and many of his neighbours have been motivated to do the same. He strongly believed that soil fertility should be improved through the use of organic matter. As a regular visitor to the Agricultural Research Station in Girandurukotte, he had observed a patch of yellow flowering *Sesbania rostrata* growing in a rice field. When he was told of *Sesbania*'s potential benefits as far as improving soil fertility was concerned, he immediately asked the researchers for some *S. rostrata* seeds to try in his own field. The researchers obliged. That was about two years ago.

When we visited Mr. Banda in July this year, he proudly showed us his rice fields. He claims he ploughs in *Sesbania* regularly and says it has improved the fertility of his land considerably. He finds the rice plants are much healthier and that they give a better yield. Another advantage he noticed was that *S. rostrata* kept soil-based pests at bay, probably due to the slight bitterness of the plant.

Although Mr. Banda is aware of the benefits of *S. rostrata*, he is unable to produce sufficient seed to maintain the required plant density over the entire one hectare area during any given season. Therefore, he resorts to a rotation of manuring. Lack of seed is also the reason why his neighbours have been slow to follow his example.

Farmer-researcher collaboration

As mentioned earlier the link between the farmer and the researcher was bridged by the extensionist in traditional extension. It was the latter who brought the farmers' problems to the notice of the researcher, and returned their advice to the farmers. Direct interaction between researchers and farmers had been minimal. PMHE recognises the need for strengthening collaboration between all actors, namely researchers, extensionists and farmers and hopes to use farmer experiments to this end. This Maha (October 1997-February 1998) researchers such as Mr Cyril Bandara and the Mahaweli extensionists will be linked to farmers trying out *S. rostrata* on their fields so that experiences and knowledge can be exchanged. ■

References

- Daney, MLG, Miyan MDS, Furoc, RE and Ladha, JK A **preliminary report on the responses of *S. Rostrata* to inoculation under flooded and unflooded conditions** Paper presented at the Third Scientific Meeting of the Federation of Crop Science Societies of the Philippines, University of the Philippines at Los Baños, 28-30 April, 1987.
- Nagarajah, S, Neue, HU, and Alberto, MCR 1989 **Effects of Sesbania, Azolla and rice straw incorporation on kinetics of NH, K,Fe, Mn, Zn, and P in some flooded rice soils.** *Plant and Soil* 116:37-48
- Dreyfrus, B, Dommergues, YR 1983 **Use of *S. rostrata* as green manure in paddy fields.**