Growing rice on raised beds

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Rice farmers in Eastern Indonesia are facing an uncertain future. The area is characterised by a monsoon rainfall pattern, but the wet season is often short and unreliable. Periods of intense rain often cause waterlogging and flooding and can be followed by periods of two weeks or more when no rain falls. Because of this, rice crops fail much too often.

Permanent raised beds are a potential alternative to present rice growing systems. By using water more efficiently, the risk of crop failure may be reduced. In addition, other crops can be grown on the same plots in rotation with the rice, creating a more diverse and secure system.

Crops other than rice can be grown on raised beds in the wet season. Photo: Author.

Permanent raised beds

The idea of growing crops on raised beds is nothing new to Indonesian farmers. In many parts of Indonesia after harvesting rice, farmers plant vegetables on raised beds so that they can be irrigated from the furrows without the risk of water logging. Each season, a lot of work is put into creating these beds after the rice has been harvested only to destroy them again in order to flood the following rice crop.

On the island of Java, farmers use a similar system, called *Surjan*, which combines upland crops and rice in one field. The system is established by moving the soil from one half of the field and placing it on the other half to form raised fields. Rice is grown on the low part and upland crops on the raised part. This system allows farmers to grow crops other than rice in the wet season. However, a lot of work is required and the soil needs to be deep enough to establish the system.

A major breakthrough came with the discovery that rice does not need to be flooded to grow well (this is also an important concept in the Systems of Rice Intensification (SRI) approach, see *LEISA Newsletter* Vol 16.4 p 12). Experiments with permanent raised beds have shown that flooded rice varieties can produce similar yields on permanent raised beds as in flooded paddies, while using much less water.

Trials in West Timor

In West Timor, upland crops are traditionally grown in swidden gardens on the hillsides in a slash-and-burn system, and flooded rice is grown in the valleys in the wet season. In recent years, however, both these systems have come under pressure and no longer provide food security.

Swidden gardens have been cultivated in the area for hundreds of years. Crops like cassava, maize, pigeon pea, and pumpkins do not need as much water as rice. They are grown on the hillsides because the more fertile lowland areas waterlog in the wet season. However, yields from these slash and burn gardens are limited by a lack of rain, poor soils, weeds and erosion. An increasing population has meant that farmers have to return to the same plot of land too soon, and the fallow period is not long enough to restore soil fertility. To reduce the risk of crop failure, farmers may cultivate three or four swidden gardens with distances of 5 to 10 km between gardens. This increases the chance that at least one field receives enough rain at the right time for a successful harvest, but it also increases the labour and time required to walk between these gardens.

Flooded rice (*Oryza sativa*) is grown in the valleys. Large amounts of water are needed and yields are very vulnerable to water shortages. If there is not enough water at the beginning of the wet season, land preparation can be delayed. If there is not enough water while the crop is growing, yields can be low or even fail completely. If the wet season ends too early and the rice plants have not yet filled the grain, the grains can be empty or only partly filled at harvest time.

During the 1998-1999 wet season an on-farm experiment was conducted in the village of Oenesu in West Timor. Five hectares were developed with a combination of small and large raised beds (see Box). Traditional upland intercrops and fodder species were planted on the large beds. Soybeans and rice (*Oryza sativa*) were planted on the small beds.

In the wet season, the rice and upland crops planted on the raised beds utilise the available rainfall. In the dry season, if irrigation water is available, it can be supplied to the furrows at a constant rate, maintaining the water level about 0.1 metre below the bed surface. An alternative to this system is to supply water at regular intervals, for example twice weekly, to rice grown on raised beds within bunded fields. If there is no water available for irrigation after harvesting the wet season crops, drought-resistant crops like sorghum, pigeon pea and cassava, or quick-maturing crops, like mung beans and millet can be planted and left to grow on the moisture stored in the soil.

Two types of raised bed

Small beds: Small beds are at least 30cm high from the bottom of the furrow to the top of the bed. They can be 60cm to 1.5m wide, depending on the soil type. These beds are suited to the cultivation of lowland rice and soybeans in the wet season. These crops do not need very much soil above the water in the furrows to grow well.

Large beds: Large beds are at least 2m wide and at least 50cm from the bottom of the furrow to the top of the bed. They are suited to the cultivation of upland crops, fodder grasses and trees, as these plants need a greater volume of soil above the waterline to grow well in the wet season. Large beds can be formed around the field boundary. They can also be formed at regular intervals in the field to prevent the small beds being washed away during heavy rain.

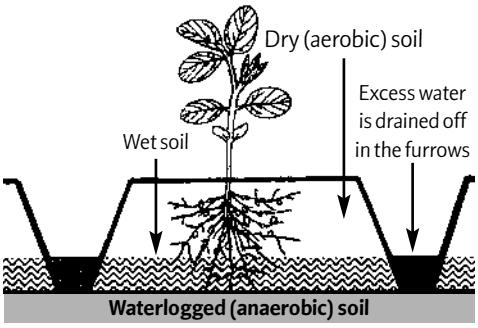
The rice on these beds gave a similar yield to the traditional rainfed flooded system. Grain yields were 1.5 to 2 ton/ha, including the furrows. The farmers had never seen soybeans grown in the wet season before. They thought that only rice

would grow in the wet season. But the most outstanding result was that the yield of the intercrops was so great that they had to get people from the next village to help them harvest it. They had never had such a bountiful harvest. The beds are permanent so the farmers can use them each year.

Potential benefits

Earlier planting
A major constraint to wet season rice in Eastern Indonesia is delayed planting when there is not enough rain to puddle the soil before sowing. If planting is delayed at the start of the season, the crop is likely to experience drought at the end of the season. On permanent raised beds, water is not needed to puddle the soil before sowing. Rice seed is sown into the top of the beds at the beginning of the wet season in the same way as upland rice.

More efficient water use
While the rice is growing, water is stored in the furrows to reduce evaporation and seepage through the soil. Permanent raised beds also provide excellent drainage during heavy rainfall. Furrows between raised beds and on-farm dams can capture water without causing water logging. This means there is more water available to the crop during dry periods. After harvesting the rice, drought-resistant crops like sorghum, pigeon pea and cassava, or quick-maturing crops, like mung beans and millet can be planted and left to grow on the moisture stored in the soil.



Less walking
Growing rice and upland crops on raised beds enables upland swidden gardening and rice cultivation to be combined in one field. More efficient use of water on the permanent raised beds means that widely dispersed gardens are no longer necessary.

Greater flexibility
Raised beds give farmers the flexibility to choose between a variety of crops at short notice, because no pre-season or crop-specific land preparation is necessary.

Diversification
Raised beds enable farmers to grow a range of crops in the same field. Various traditional intercrops have been successfully grown on raised beds. A combination of grain, legume, tuber, fodder and fruit species can be grown in the wet season and, more importantly, the total yield and the nutritional value of this combination is far greater than that achieved with rice monoculture. Crops are harvested over a long period, so that food is available throughout the year. The eroded upland cropping areas can be reforested with a range of perennial species to provide food, fodder, firewood, building materials and medicines, since the basic food and cash crop requirements of subsistence farmers can be met from intensive lowland production on permanent raised beds.

Crop rotation
Crops can be rotated to control weeds, to reduce the build up of pests and diseases and to reduce the need for external inputs. Including legumes such as soybeans in the crop rotation can help fix nitrogen and reduces reliance on inorganic fertilisers. Incorporating the crop residues can also improve the organic matter content of the soil.

Important considerations

A major limitation to implementing a raised bed system is the initial labour required. Extra labour is needed to till the soil and form the beds during the dry season. Drains also need to be dug so that the excess water does not wash the beds away. Organisations that have expertise and access to credit need to work with farmer groups to implement the system. Although the initial inputs are high, the total yields from the system are higher than rainfed, flooded rice and farmers save labour in subsequent years. It should, therefore, be possible to repay initial inputs within a few years.

To plan a balanced, low-external input system it is important to consider environmental factors such as the species to be used, soils, and crop rotations. The on-farm trials showed that rice grown on raised beds can yield the same as rice grown in flooded conditions. However, other rice varieties, for example, traditional upland rice varieties that can withstand periods of water stress, may be better suited to the raised bed system. Permanent raised beds are suited to areas where water is limited but, because of the high clay content of the soil, crops become easily waterlogged when it rains. Soils that are rocky, shallow or do not hold their shape, are not suitable. Factors such as fertility, organic matter content and pest and disease control should be taken into careful consideration when planning crop rotations.

Growing rice on permanent raised beds is still a relatively new technology. The many different factors that contribute to its success or failure have not yet been fully defined, and many factors, such as soil type, are locally specific. Therefore, it is important to first try the raised beds in a small area. The beds can easily be introduced in stages, for example, by first building wide bunds around the rice fields that can be planted with upland crops, to reduce the risk of failure. ■

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