Sustainability of intensive rice production threatened

Use of agro-chemicals, continuous irrigation and intensive mechanisation leads to soil degradation.

photo: Bert Lof

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The sustainability of intensive rice production is under threat and the problem is attracting increasing attention. An exploratory study was carried out for the ILEIA Research Programme to establish an overview of the ecological and economic impact of development trends in rice production (Kabir, 1999). The study was based on a literature survey and was subsequently reviewed by rice specialists from PhilRice, PCARRD and UPLB. This article summarises the main findings.

The intensification of rice production on the humid lowlands has meant that relatively extensive systems based on one annual rain-fed or irrigated rice crop and drought resistant crops or fallow vegetation have been turned into an intensive rice monoculture of two or three crops of rice. This has brought about several important changes in the production system.

- Year round production with a limited number of rice varieties.
- Rice paddies flooded most of the year without adequate drying period.
- Heavy dependence on inorganic fertilisers and pesticides;
- Greater uniformity in the varieties cultivated.

These production system changes have lead to long-term biophysical changes in the natural resource base. This threatens the ecological sustainability of rice farming (Pingali et al, 1997). At research station and farm level, these trends are reflected in declining factor productivity and falling profitability and input efficiencies. All have serious implications for economic sustainability.

Yield decline has been recorded in long-term, on-station experiments in several countries and at IRRI's in-house research station. However, yield decline at farm level has yet to be confirmed by scientific assessment. Rice production and yield growth rates are slowing down and, in the major rice growing countries, fall well short of population growth. The processes and trends discussed below threaten the ecological and economic sustainability of intensive lowland rice production.

Soil management

The chemical fertilisers used in rice production have a low and declining efficiency. Nutrients are lost through volatilisation, de-nitrification, percolation and run-off. Forty to seventy percent of the chemical nitrogen applied to the soil is lost to the environment leading to air pollution and pollution of ground and surface waters. At the same time, increased methane emissions contribute to climate change - the greenhouse effect.

Declines in the partial factor productivity of nitrogen fertiliser have frequently been observed. Recent work at IRRI suggests that continuously irrigated wetland soils have a reduced capacity to supply nitrogen. Flooded soil mineralises organic matter very slowly. Huge amounts of nutrients are lost through the removal and burning of rice straw. When rice straw, for example, is removed from a one hectare plot of HYV rice, 66kg N, 6kg P and 160kg K are lost as well. This loss, together with imbalances in the use of fertilisers, has increased the incidence of phosphorus, potassium and micro nutrient deficiencies in many rice soils.

Seasonal cycles of mechanised ploughing and puddling over a longer period result in the formation of hard pans and water logging in paddy soils. While favourable for rice production, these hard pans create problems for subsequent non-rice crops and this limits diversification within intensive rice systems.

Water management

Since 1979, the expansion of irrigated land has lagged behind population growth. This is mainly because of increasing irrigation costs, inadequate government investment, and policies that favour privatisation. Due to insufficient drainage and low water quality, 25% of irrigated rice suffers from some degree of salinity. Severe upland erosion causes siltation that in turn affects the storage capacity of reservoirs and reduces the amount of irrigation water available. Because of over-pumping and increased run-off there has been a steady and widespread decline in ground water reserves. At the same time, the rapid pace of industrialisation and urbanisation has resulted in growing competition for scarce land and water resources

The amount of irrigated land is shrinking rapidly due to population growth, urbanisation and industrialisation. In China, for example, where land is in short supply, nearly 4 million hectares of cropland - most of it in irrigated areas - has been lost. In addition, large tracts of irrigated land are no longer in production because existing irrigation infrastructures are poorly maintained.

Pest management

Continuous rice cultivation, uniformity in the varieties cultivated and the injudicious use of pesticides has lead to the build up of pests in irrigated rice systems and to further increases in pesticide application. Many pests become resistant to pesticides, fungicides and herbicides. Pesticide is used because it is believed that rice production is not possible without high levels of chemical pest control. A recent study by IRRI has shown that 80% of the pesticide applied by rice farmers were unnecessary. Pesticides cause ecological and health problems for humans and animals. They also contaminate surface water and this is one of the main reasons why the natural predators of pests and diseases as well as edible fish, frogs, snails, crabs and shrimps have disappeared from natural and farm environments.

Integrated Pest Management (IPM) has proved effective in reversing these trends. In countries where it has been encouraged there have been significant decreases in the amount of insecticide used. However, alarming amounts of herbicide are still being used to offset increasing labour costs and to facilitate direct sowing.

Crop improvement

Intensive rice monoculture is dominated by modern varieties with a very narrow genetic base. Traditional rice varieties are becoming increasingly rare and are only used by a few farmers. There has been little increase in the yield potential of modern varieties since the 1960s. Only hybrid rice varieties have a higher potential but these are more expensive and need well-controlled irrigated conditions. Poor and marginal farmers often cannot afford them. In regions with favourable production conditions the yield levels of many farmers come close to the assumed yield potentials of the modern varieties.

Researchers, using genetic engineering, are now trying to develop new, super rice with a yield potential of 13-15t/ha. Although it is still too early to assess the economic, social and ecological impact of the super rice, it is doubtful whether it will be able to improve the economic position of the small farmer. The full risks of genetically engineering a major food staple are also not yet fully understood.

Because doubts are being raised about the ability of plant breeders to increase the yield potential of rice. The necessary increase in food production must, therefore, come from an increase in average yield. This will be difficult in places where crop production has already been greatly intensified. When yield levels come close to 75% of their potential maximum, the incidence of disease will increase, the number of pests will intensify and it is difficult to keep soil in good condition. This means that it will be increasingly important to improve rice yield in less favourable conditions.

New insights into rice ecology indicate that the yield potential of available rice varieties is much higher than has been assumed (see article on the 'System of Rice Intensification in Madagascar. ILEIA Newsletter Vol 15. 3 & 4, December 1999). Considerable yield increases may be possible without the use of genetic engineering and may also be within the reach of poorer farmers working in marginal conditions.

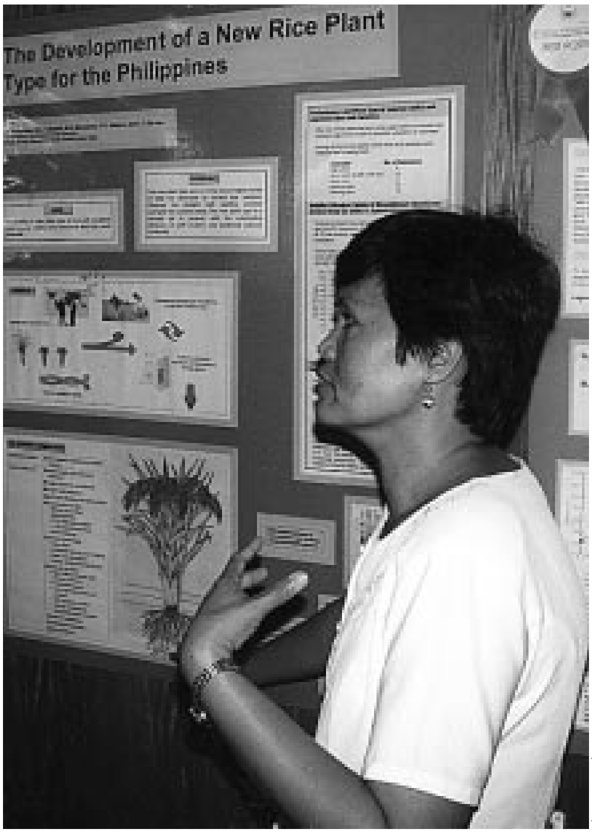

photo: Bert Lof

New super rice has high yield potential but the risks for small farmers are yet unknown.

Farmers are leaving the land

Higher wages in urban areas and rural poverty cause labour migration from the countryside to the towns. This creates a labour crisis on the land particularly during seasons when farm work is heaviest. When labour becomes scarce and more expensive, farmers are forced to use labour saving technologies including herbicides and mechanisation. In the long term this may lead to an increase in the size of rice farms.

The declining efficiency of chemical fertilisers, pesticides and irrigation water induced by the above mentioned ecological problems together with the increasing costs of labour and inputs relative to the price of paddy have contributed to making rice farming less profitable. Liberalisation and the globalisation of the rice market have put further pressure on rice prices. The general decline in the terms of trade between agricultural and industrial products and services has also helped to marginalise rice farming economically and farmers are being forced to look for other sources of income. Young people are being driven to seek employment outside agriculture and, in the long-term, this may mean that the number of farmers will decline.

Rice farming towards sustainability

Such developments will affect the future of rice farming and the choice of technologies and policies will heavily influence the sustainability of the rice economy. The available technology options developed by scientists and innovative, traditional and ecological farmers should be carefully analysed and their economic, social and ecological impacts described. Results can be used to support the decisions made by farmers, researchers and policy makers in their efforts to secure sustainable rice production.

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