

More rice with good soil fertility management



Photo: Ana Primavesi

Many people believe that lowland rice produces best when it receives water and minerals as if hydroponic techniques were being applied. But rice does not grow in water. It grows in soil and NPK fertiliser adds only 3 of 45 minerals needed for full development. Green Revolution technology has caused soil degradation and this is becoming

Ana M. Primavesi

ing increasingly visible. Sooner or later this will lead to stagnation or a decrease in yield. Degraded soils produce low quality food and this has a direct effect on human health. Far from rescuing populations from famine, the Green Revolution is becoming a threat to food security.

However, soil productivity can be recovered. In southern Brazil we developed an alternative concept of irrigated rice production based on soil aeration, crop rotation, the restoration of organic matter and micro nutrients.

Soil reduction and growth

In submerged condition the amount of minerals available is reduced and oxygen ions are replaced by hydrogen ions. Some of these reduced minerals - SH_2 ; NH_3 ; CH_4 and MnH_2 - are extremely toxic to plants. A high pH in wet soil indicates that a very strong reduction in mineral compounds has taken place. In all low yielding soils, agronomists found dry soil was low in pH. In submerged conditions, however, it was high. In reduced conditions rice is poorly nourished and yield decreases.

Impoverishment of the soil can be halted if soil is drained just after the rice plants begin to emerge. Rice roots follow soil moisture and in doing so they penetrate below the reduced top layer. When plants begin to wilt, the field is irrigated and re-submerged for a short time. In this way rice grows in the oxidized rather than in the reduced soil layer. In sandy soils this is impossible because the reduction layer may extend to a depth of 70 to 80cm and roots rarely go so deep. The longer land is kept under monoculture the stronger the reduction effects will be.

Controlling soil reduction

Soil reduction can be controlled if soils are drained completely after rice has been harvested. In addition irrigated rice should be rotated with crops such as barley wheat

soya beans and vegetables that do not need ponded irrigation. Organic fertilisers such as *Sesbania*, compost, farm yard manure and mulch should be applied to the 'dryland' crop. It not only fertilises the crop but it also saves water. Rice soils, it is believed, do not need liming because pH increases in submerged condition. However, lime does not only neutralise pH, it also nourishes the plant. Liming can raise rice yield considerably.

The reduction process in the soil layer can be brought under control if the soil layer is broken by roots and small soil organisms such as earthworms and insects. Soil must become porous again to allow minerals to oxidise and only the rice ears should be harvested because most of the straw should be incorporated into the top 8 cm of soil. In that way the straw will be able to contribute to oxidation, fertilisation and the improvement of soil structure. If ploughed in to a depth of 15 to 20 cm, straw will fix the nitrogen present in the soil and repress crop growth for a period of 3 months or more.

Nutrient deficiencies

If only NPK fertiliser is applied the soil will become depleted of the other nutrients rice extracts from the soil. Three to five years of NPK fertiliser is enough to exhaust the soil. Vegetables and fruits lose their biological value, taste and smell, and require at least 15 additives when canned to make them palatable. Cereals produced in these conditions are poor in proteins, fatty acids and higher sugars.

Soil nutrients have to be balanced. High doses of ammonia fertiliser lowers potash, calcium and magnesium absorption while high doses of nitrate fertiliser lowers the absorption of phosphorus and sulphur. This seriously disturbs the metabolism and productivity of the plant and reduces its resistance to parasites. Nutrient balances are best maintained with organic fertilisers. Very pronounced nutrient deficiencies, however, must be corrected chemically.

Rice frequently lacks copper, manganese and zinc. This is indicated by rice blast (*Piricularia oryzae*). Leaf analysis of blast-sick plants shows deficiencies in both manganese and copper. Spraying rice seeds with a solution of 1.0% of copper sulphate and 0.5% of manganese sulphate makes them able to absorb these nutrients. When 2.5 to 3 kg/ha of copper sulphate and 5 kg/ha of manganese sulphate are applied with the irrigation water no blast appears. When husks emerge without grain, copper is lacking. If varieties are used that are not well adapted to the soil some micro nutrients are nearly always required.

Herbicides

The two most problematic weeds in irrigated rice production are *Echinochloa* and red or bitter rice. Bitter rice can be more or less controlled by using pre-germinated seeds and seeding in slightly submerged soil. Crop rotation also helps. *Echinochloa* species can be combated with herbicides but this is not strictly necessary as *Echinochloa* plants are adapted to reduced soils. When reduction is strong, *Echinochloa* are more difficult to control. When this is the case, soil drainage and green manuring provide the best control.

When drainage, organic amendments, crop rotation and micronutrients are applied, yields can increase from 4,000 kg/ha to more than 11,000 kg/ha and the percentage of entire grains after husking can increase from 48% to 62%. Good soil fertility management is the basis for high yields and quality. ■

Ana M. Primavesi, Fazenda Ecológica, Caixa Postal 36, 18730-000 - Itai, São Paulo, Brazil.

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