

Sustainment of crop production in the unfertilized, traditional rice farming, Dry Zone, Sri Lanka

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Introduction

Are chemical fertilizers a must for sustainable crop production? Did our ancestors use the fertilizers to produce rice? If not, how did they achieve sustainable yields in the past? This article answers those questions.

Before green revolution, farmers cultivated rice for ages without applying fertilizers, but yields were sustainable, and of course relatively low. Some farmers applied green matters or tree prunings cut and brought from surroundings of rice fields. Other than that they used the natural vegetation growing in rice fields during fallow periods as the source of organic matter for the crop production. During cropping season, rice crop itself contributes to organic matter through the death and decomposition of shoot and root parts etc. This article reveals the role of natural phenomena occurring during fallow period and cropping season that help in sustaining crop production in this system.

Fallow period

Fallow periods in lowland rice of the dry zone of Sri Lanka are often a result of lack of irrigation water. Village-tank based irrigation systems in the dry zone provide water mainly during "Maha" season. During "Yala" season, paddy fields are generally kept fallow. Initially, sedges dominate in the fallow vegetation. They are followed by grasses and then legumes. This also accompanies a shift of the vegetation from annuals to perennials. Organic matter produced after the death of these plant groups is decomposed and incorporated into the soil. This changes soil pH, organic matter content and hence soil compaction. These changes are important for the sequence of domination of the groups of plants along the fallow period, especially from annuals to perennials. During the plant succession, a build-up of plant N takes place and it simultaneously reduces soil mineral N through absorption, an ideal natural mechanism to conserve soil N, without letting to lose through leaching and gaseous forms. The plant groups along this period also show a tendency of reducing mineral N release after death and decomposition, thus increasing soil organic N. This is how soil organic matter is built-up during the fallow period.

When grazing by cattle prevails during the fallow period, it controls annual weeds in the succeeding rice crop, which would otherwise infest and reduce drastically rice yields. Grazing also helps in conserving a considerable portion of soil mineral N in a non-exchangeable pool, which could be used during the cropping season.

This is possibly due to soil compaction with trampling by cattle during grazing. During this period, a nitrogen-poor soil with pH of *ca.* 6.8 is found in the paddy tract. Those are ideal conditions for biological nitrogen fixation (BNF). Nitrification is also reduced considerably, possibly due to soil compaction, thus diminishing leaching and gaseous N losses. Soil drying during the dry spell of the fallow period helps in improving germination and growth of rice, after re-wetting soil in the subsequent cropping season.

Cropping season

During the rice-cropping season, soil pHs ranging from 6.8 to 7.0 prevail with relatively low mineral N concentrations. These conditions again favor BNF by free-living and associative bacteria around rice roots. Soil drying and re-wetting with intermittent irrigation create micro-aerobic conditions, favoring the BNF. Cyanobacteria (blue-green algae) growing in the water-saturated soil of rice fields also contribute to N budget through the BNF. The average net removal of N from the traditional rice farming is *ca.* 5 kg/ha per season. This should be replenished seasonally, if rice yields in this system are to be sustained. Evidence show that the BNF during the cropping season alone could contribute even up to *ca.* 20 kgN/ha. Therefore it is appeared that this farming system is secured and can sustain its productivity.

Conclusions

Plant succession, grazing by cattle and soil drying during the fallow period play major roles in the sustainment of crop production in this farming system. Favorable soil pH and low soil N status during the cropping season helps in a considerable accumulation of atmospheric N through the BNF. Any attempt to intensify cropping in this system that would influence those natural phenomena, may collapse the sustainment of the productivity of this system. Because the productivity has been sustaining for ages, based on the delicate balance of those natural phenomena.