

The Rice – Azolla – Fish Systems : An Ecological View

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Abstract

High-technology conventional agriculture with excessive use of toxic chemicals has polluted the environment and caused ecological imbalance. Ecological agriculture is an alternative in partly solving the problem. The principle of this alternative is to take biological processes in natural ecosystems as the basic model for agricultural practice. The rice – azolla – fish ecosystem is probably one case towards the solution.

Keywords : rice, azolla, fish

Man's reckless industrial and agricultural activities, and affluent societies have created numerous environmental problems. Major threats to the earth's environment are extinction of wild species, global warming as a result of excess carbon dioxide and other gases, enormous and poisonous wastes, and overpopulation. Some scientists realize the crises and are trying to solve the problems. The scope of ecology has been broadened and applied not only to wild plants and animals in natural environments, but also to humans on a global scale.

High – input fuel – based agriculture is a human activity which pollutes the environment and creates imbalance in the biosphere. Excessive use of toxic pesticides has created pest resistance, resurgence and secondary pest outbreaks (Dasmann *et al.*, 1974; Nebel, 1987); heavy mechanization in a large scale has caused soil compaction, accelerated soil erosion and aggravated drought stress (Lal, 1987); while excessive application of chemical fertilizers has created eutrophication (King, 1982; Nebel, 1987). Desertification and

salinization are the result of improper soil, water and crop management (Nebel, 1987). Ecological agriculture is suggested as an alternative.

Ecological Agriculture

Agriculture is primarily applied biology and it is most likely to be successful when it follows sound biological principles. Therefore, it is necessary to take biological processes in natural ecosystems as the basic model for agricultural practice. It was quoted that the guiding light of ecological agriculture came from William Albrecht (Albrecht, 1975 as cited by Oelhaf, 1978). However, application of ecology to agriculture was mentioned in many textbooks (Odum, 1968; Sutton and Harmon, 1973; Dajoz, 1977).

Kiley-Worthington (1981) suggested that ecological agriculture should be "the establishment and maintenance of an ecologically self-sustaining low input, economically viable, small farming system managed to maximise

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production without causing large or long term changes to the environment, or being ethically or aesthetically

unacceptable.” Lal (1987) proposed the concepts and components of the sustainable systems as shown in Figure 1.

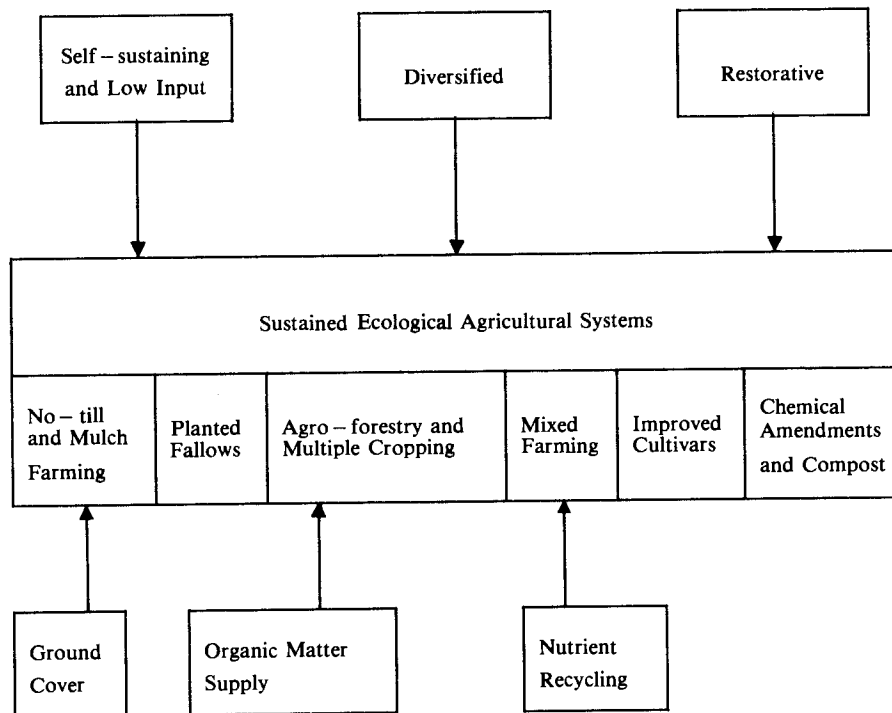


Figure 1. Concepts and components of ecological agriculture (Lal, 1987).

Biological agriculture (Hodges, 1981), sustainable agriculture (Conway, 1988), permanent agriculture (Strange, 1983) and ecological agriculture are directed towards the same goal : the balance, sustainability and stability of an agroecosystem with no resource and environmental problem.

Rice-azolla-fish systems are examples of ecological agriculture. Azolla is primarily grown as a green manure for rice, but insect infestation is a limiting factor in azolla culture.

Excessive use of insecticides not only endangers human health but also creates insect resistance and unbalance an ecosystem. Fish included in the system can help to solve the problem. Research on this aspect was reported in Thailand (Swatdee *et al.*, 1988) and a lot of work has been done in China (FAO, 1988). The rice – azolla – fish ecosystem is illustrated in Figure 2. Yield data of the system are presented in Table 1. Food chain or food web and diversity are some ecological principles possibly applicable



Treatment (kg/rai of N-P ₂ O ₅ -K ₂ O)	Rough rice (kg/rai) #	Fish (g/fish)
Rice + (6-6-4)	160 b	-
Rice + Azolla + (0-6-4)	291 a	-
Rice + Fish + (6-6-4)	291 a	46.0
Rice + Azolla + Fish + (0-6-4)'	315 a	84.3
C.V. %	13.9	

In the same column, means followed by a common letter are not significantly different at 5% level by DMRT.

to the system. Azolla may be inoculated before or after rice transplanting. Fish species should be combined or mixed with different species of different eating patterns (herbivorous, carnivorous and omnivorous). The number and ratio of fish species should be in harmony with feed source available under the rice-azolla-fish systems. The fish will feed on insects, azolla and other fish feed. Azolla biomass should provide ample feed for the fish and nutrients for azolla and the rice plant. Fish faeces are also a nutrient source. Application of ecological pyramids and nutrient cycling in the system is probably possible. The balanced establishment of an ecosystem needs to be adjusted for each local condition. The ecosystem approach assessment of the rice – azolla – fish practices should be encouraged in different situations. Some parts of research in China are good guidelines (FAO, 1988).

Conclusions

High – input modern agriculture has created pollution and ecological imbalance. Ecological agriculture is suggested as an alternative. It is an applied ecology. The goal of the alternative is the balance, sustainability and stability of an agroecosystem with no resource and environmental crisis. The rice – azolla – fish ecosystem was proposed as one example.

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