Available online at
www.agrospheresmagazine.vitalbiotech.org

ISSN (E): 2582 – 7022

Agrospheres:e- Newsletter, (2022) *3*(12), 8-10

Article ID: 451

Impact of Rice-Fish Farming on Environmental Pollution

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Article History
Received: 10. 12.2022
Revised: 23. 12.2022
Accepted: 16. 12.2022

INTRODUCTION

Rapid population growth creates a slew of issues, including food scarcity, malnutrition, limited water and other resources for agricultural output, and deteriorating environmental quality. To manage the ever-increasing food and environmental pressures, agricultural production methods must be sustainably intensified. Rice ecosystems cover 167 million hectares globally, with 134 million ha suitable for rice–fish coculture. However, only 1% of rice ecosystems are under fish culture. Rice (Oryza sativa L.) cultivation, which covers 167 million hectares of land, consumes up to 90% of Asia's total irrigation water, and feeds only about half of the world's population, is a critical component of food and environmental security. Hence, the rice cultivation has been considered as major sector for wasting the water resources and also major source for green-house gas emission (GHG). Thus, the improvement in rice production management systems needed to be focussed. Rice–fish systems can be divided into two categories: (1) capture system and (2) culture system. During severe rains, wild fish invade rice ecosystems in the capture system. Farmers stock externally sourced fish in rice fields in the cultural system. Rice–fish culture is divided into two categories: (1) integrated and (2) alternative. In the integrated system, fish and rice are grown together, whereas in the alternate system, both are produced in rotation. *Cirrhinus mrigala* H. (mrigal), *Labeo rohita* H. (rohu), *Catla catla* H. (catla) (three Indian main carps), and *Cyprinus carpio* L. (common carp) are the most significant fish species for aquaculture in India and Southeast Asia. Understanding the significance of each species in greenhouse gas emissions is critical, especially because they have diverse eating patterns and behaviours in rice-fish systems. Oxygen shortage and reduced condition are two features of flooded rice soils, both of which favour CH_4 generation. This article mainly focuses on the impact of Rice-Fish farming on the environment quality.

Effect of rice fish culture on water quality

Rice monoculture is a major source of pollutants to waterbodies of downstream, as agrochemicals such as fertilizers and pesticides are applied to standing water in the field. In paddy monoculture Nutrient (mainly N) use efficiency is very low due to losses to the environment as contaminant. Improvising the quality of water has become important objective for sustainable rice production. The Nitrogen Use Efficiency (NUE) is more in rice fish culture as there is an addition of extra consumer, i.e., fish, crabs, shrimps. etc., as there is very less loss of N to the environment.

When compared to rice monoculture, rice-animal (fish, prawn, crab, etc.,) co-culture has been shown to minimise chemical fertiliser inputs by 24 percent while maintaining the same rice output. When compared to fish monoculture, rice-fish co-culture lowered nutrient concentrations in water samples by 70-79% for different elements of N (total N, NO_3-N, NO_2-N and NH_3-N) and P (total P and dissolved organic P). Furthermore, through natural weed predation by animals, co-culture systems can reduce pesticide use by up to 68 %.

Methane (CH_4) emission

Paddy monoculture contribute to about 20% of global methane emission. Under submerged conditions with decreased oxygen availability, anaerobic decomposition of organic compounds such plant wastes, organic debris, and organic fertilisers produces methane. Aquatic animals, particularly bottom feeders (crabs and carps), disrupt the soil layers with their movement and, in quest for food, and so have an impact on CH_4 generation. Aquatic animals may raise Dissolved Oxygen (DO) in field water and soil, causing anaerobic digestion to change to aerobic digestion and lowering CH_4 emissions. A rice-crayfish co-culture system lowered CH_4 emissions by 18.1-19.6% and global warming potential by 16.8-22.0 % when compared to paddy monoculture. As water quality has been improved in field water (less eutrophication and more DO), there prevails aerobic conditions and results in less methane production. However, some studies have shown increment in methane emission as a result of rice-animal co-culture. More research has to be evolved to study the influence of water level, paddy and aquatic animal stocking density on methane emission.

Nitrous Oxide (N_2O) emission

One of the primary N loss channels to the environment is nitrous oxide, which has a global warming potential 298 times more than CO_2 and contributes significantly to GHG emissions. Under submerged circumstances, rice fields are a source of anaerobic digestion, which has the potential to disrupt microbial nitrification and denitrification, resulting in N_2O emissions. Gaseous N emissions in this environment are influenced by intensity of N fertilisation, water drainage, and microbial activity, which account for up to 69-70% of gaseous N emissions from paddy systems. Adoption of rice-fish culture plays a key role in GHG emission mitigation and improves farm income with better usage of resources. In rice co-culture systems, *viz.*, rice-fish, rice-cray fish, rice-crab, rice-duck significantly reduces nitrous oxide emission. Research has proven that rice-crab culture reduced the cumulative nitrous oxide emission seasonally by 19 - 28.3%.

Bio-diversity

The importance of biodiversity in ecological service cannot be overstated. Unfortunately, rising world population and food demand are threatening biodiversity in both the terrestrial and aquatic environments. Maintaining biodiversity in aquatic habitats has become a particular issue, since biodiversity has been significantly impacted by environmental stresses and water pollution caused by human activities. Mono-shrimp farming, for example, has had a detrimental impact on biodiversity in coastal regions, as it tends to cause substantial biodiversity damage by harming flora and animals. Rice-animal co-culture systems, on the other hand, have been shown to sustain biodiversity, with a variety of aquatic flora and wildlife being recorded in rice fields.

Biological control of pest

Carps introduced in paddy fields eat larvae, stem and leaf eating worms, and other worms. This results in fish population expansion and biological management of rice pests. This is because many fish species graze on aquatic creatures. They are thought to have a function as biological controllers in rice fields. Furthermore, research has been conducted to see if fish culture may be used to decrease pest bug populations and other pests of rice plants. The *Pomacea canaliculata* has become one of the most dangerous pests of rice plants in Asia since its arrival in the 1980s and continues to cause economic damage. In general, common carp is evolving into an omnivore, and it appears to be one of the most promising species for controlling insects and snails. Fish's ability to suppress pests may allow for a reduction in the use of plant-supporting pesticides. Farmers will be required to reduce pesticide use because many new substances used for fish are harmful or can accumulate within the fish tissue. If live fish can replace several pest chemical treatments, it is a natural step forward. Pesticide use in rice agriculture is currently thought to be unsustainable, both economically and environmentally.

CONCLUSION

A long-sought answer for sustainable agriculture may finally be found in integrated rice-fish farming, which makes the best use of available space and resources. It might make a significant difference in the health and prosperity of the disadvantaged and underprivileged farmers in emerging nations like India. Additionally, the reduction of pesticides and fertilisers in rice fields may aid in environmental preservation and the reduction of climate change's negative consequences. The rural youth may find employment opportunities through integrated rice-fish farming, and they may gain from such entrepreneurship activities. But all of this would be doable with sufficient government support, such as simple access to loans for putting up early infrastructure, educating and training small and marginal farmers, and establishing suitable market connections for them. Additionally, focusing on research in the areas of water management, biofertilizers, biocontrol agents, and fish species with rapid growth might boost profits without affecting the environment.

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