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Rice and Fish: Impacts of Intensification of Rice Production

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Rice and Fish:

Impacts of Intensification of Rice Cultivation

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Cambodia's paddy fields have traditionally produced fish and other aquatic animals (OAA) in addition to rice. These fish and OAA are an important source of nutrition, particularly for the poor. Intensification of rice production, with increased use of agricultural chemicals and changed water regimes, potentially threatens fisheries in rice-fields and adjacent waterways. What can be done to safeguard rice-field and small-scale fisheries while enhancing rice production?

Rice-Field Fisheries

Cambodia's seasonally inundated rice-fields and adjacent small waterways (streams, canals, and ponds) are a richly bio-diverse ecosystem. In the wet season, rice-fields become an extension of the floodplain wetlands, hosting a wide variety of fish as well as frogs, crabs shrimps, snails, and insects (other aquatic animals, OAA).

Fishing and foraging in flooded rice fields is an important source of food and seasonal income for almost all rural households for some part of the year (Hortle et al. 2008; Joffre et al. 2012). It is estimated that, in addition to wetland vegetables, rice-fields provide around 50 – 250 kg of fish and OAA per family per year (Hortle et al 2008, (Shams 2007)). The economic value of this capture and collection can approach, or even exceed, the value of the rice harvest: for example, Hortle et al (2008) estimated the value of fish and OAA from rice-fields in Battambang to be around USD100/ha, compared to about USD 150/ha for a single wet season rice crop at the time. More importantly, fish, OAA, and vegetables from rice-fields are an important source of essential proteins and micronutrients, particularly for the poor. As many as 60 species of fish have been documented in rice fields and community refuges by World Fish (Alan Brooks, pers comm). These fish may well constitute a household's primary and most affordable source of animal protein, and certainly represent far greater nutritional values than rice. Wet season rice-field fishery is traditionally a common pool resource, with few restrictions on access.

Fish use rice-fields as breeding, spawning, feeding, and growth habitats. As such, these fields are an integral part of the national fisheries sector, valued at around USD1 billion annually (So & Touch 2011), and represent up to 28% of the inland freshwater fisheries sector (Joffre et al 2012). The RCG's Strategic Planning Framework for 2010-2020 (FiA 2010, cited in Joffre et al 2012) sees rice-field fisheries as an essential component of national strategies to increase fish-catch in order to meet the rising domestic demand for food. The Framework envisions a 15% annual increase in catch in order to reach 0.5m tonnes by 2019 (compared to 0.11 m tonnes in 2000).

Rice-fish co-culture can also have significant benefits in terms of rice production. Indigenous carnivorous black fish and naturally occurring predators such as frogs and toads are known to play a role in pest control, although their value has not been scientifically evaluated (Hortle et al. 2008). A study in China found that rice yields of rice-fish systems were equivalent to that of rice monocultures, but with much lower inputs (68% less pesticide and 24% less chemical fertilizer) and lower nitrogen releases to the environment (Xie et al. 2011). However, other research (Halwart and Gupta 2004) points out that special conditions are needed for co-culture to work. Farmers usually need to modify their fields, have good capacities/skills, deal with predators, and ensure low pesticide levels in the natural systems. Specific circumstances (e.g. if there is a good supply of wild fish during floods) will also determine whether the necessary investments will ultimately be profitable for farmers.

Impacts of Rice Intensification

Traditional rice growing techniques in Cambodia involve prolonged inundation of fields, with no or very low inputs of chemical fertilizers and pesticides. Intensification of rice production is likely to create conditions that are less favorable for many aquatic organisms. By increasing the use of agrochemicals, changing water management practices for irrigation, altering habitats, and creating barriers to fish migration by constructing irrigation infrastructure, farmers are likely to negatively impact the ecology of rice-fields in a number of ways (Nguyen-Khoa, Lorenzen, et al. 2005).

Pesticides arguably pose the greatest threat to rice-field fish and OAA. Estimates of the total amount of pesticides used by farmers are difficult to obtain, given that probably 80-90% of pesticides used are imported unofficially through Thailand and Vietnam (ACI 2002; EU 2012). As a result, highly toxic pesticides banned in many countries (like organophosphates and organochlorines, including DDT) are in common use (Graber Neufeld et al 2010; Wang et al 2011). Most farmers use limited pesticide in the main wet season crop, but application rates are higher for the dry season and early wet season when pest populations are at or near the peak of their annual cycle (ACI 2002). Interviews with farmers in Prey Veng indicate that 5-7 applications of pesticide in a season are not unusual (Thuon Try, this study). There is little understanding of proper dosages, leading to overuse and misuse of chemicals, which is also exacerbated by a lack of labeling in Khmer language. Return of irrigation water to canals, streams, and groundwater means that the impacts of chemical use are not restricted to the people who use it, or to localized ecosystems. Thus, the potential for damaging key natural resources that underpin a range of rural livelihoods across a large population is high.

Development of dry season irrigation may have little impact on fisheries as long as wet season rice-fields, which dominate the wet season habitat, continue to be managed as deep-water systems (Nguyen-Khoa et al 2005). However, adoption of changed in-field water regimes may have a profound impact on the viability of rice-field fisheries. Alternative rice production systems designed to enhance productivity and decrease water use are being investigated by IRR and CARDI; these include alternate wetting and drying (AWD) and cultivation of aerobic (non-flooded) rice (IRRI – MAFF - CAVAC 2012). RCG is promoting the use of the System of Rice Intensification (SRI), which includes alternate wetting and drying of fields (Ly et al. 2012). In many areas, intensification involves a shift from a long period wet season crop to two shorter period crops at the beginning and end of the wet season, with a reduction of continuous inundation periods. This can be expected to decrease overall aquatic productivity, since rice-field catches are higher in sites that are deeper and inundated for longer periods (Hortle et al 2008).

Construction of irrigation infrastructure (canals and dams) significantly changes riverine ecosystems. Impacts on biodiversity are almost invariably negative, but overall productivity at local scales may not be affected, as reservoirs and canals can provide an alternative fishery. For example, a study in Lao PDR (Nguyen-Khoa et al. 2005) noted a shift in fishing effort to the reservoir, but with no significant loss in overall productivity. Findings from other sites suggest the opposite. Dams act as barriers to fish migration and can cause a very significant decline in the population of migratory fish (Halls & Kshatriya 2009). Thuon et al (2007) reports a decline in species numbers from 79 to 53 species after construction of the Stung Chinit scheme, despite the operation of a fish ladder. Declines in reservoir fisheries were also noted in the Kamping Pouy and Boeng Sne Irrigation Schemes (de Silva and Senaratna-Sellamuttu, this study). Fisher folk attributed this to the difficulty of regulating access across multiple communes and to the loss of seasonally inundated forests (which previously acted as fish nurseries). Also relevant is the fact that many of the fishers represent lower income groups that do not own agricultural land, and hence depended more on fishery. Introduction of the canal system also appears to have brought advantages to farmers closer to the main canal. These farmers block the canal and monopolize access to migrating fish at the expense of both more marginalized and smaller scale farmers, as well as reservoir fishers. Thus, not only has total fish catch declined, but the negative consequences also appear to be borne by already marginalized households.

Mitigation and Management Measures

A range of measures is proposed to safeguard and enhance rice-field fish production.

Reduction of Pesticide Use

Regulation of pesticides is an urgent priority; in December 2011, Cambodia signed the Law on Pesticide and Chemical Fertilizer Control to enforce the registration and safe use of agrichemicals but implementation is still limited (EU 2012). Farmers must also be educated in proper use of pesticides while integrated pest management approaches are encouraged. Use of the SRI, with reduced input of agrochemicals (Ly et al 2012) is another possible solution.

In-Field Water Management

Nyugen-Khoa et al (2005) concluded that the effects of irrigation farming practices and water management on fish are as significant as those of infrastructure. A better understanding is needed of the impact of changing in-field water regimes on fish and OAA, and how irrigation can be made more fish-friendly.

In-Field Refuges

At field scales, where alternate wetting and drying is used (e.g in SRI), slot trenches in the field can provide a refuge for fish, although this involves sacrificing a proportion of the rice field (Oxfam America, pers. comm.).

Community Refuge Ponds (Man-Made or Natural)

Refuge ponds and stock enhancement are being promoted in order to enhance rice-field fisheries by providing dry season sanctuaries for brood fish in seasonally inundated systems. The approach combines aquaculture technologies (releasing cultured organisms into natural environments) with fishing access regulations (seasonal no-take zones) (Joffre et al 2012).

Reservoir and Pond Aquaculture

Culture fisheries are developed in reservoirs and ponds by stocking them with fingerlings and/or brood fish from hatcheries. However, the environment may need to be manipulated to improve productivity (e.g. fertilization of the pond) and fisheries in small reservoirs must usually be sustained through regular stocking (De Silva & Funge-Smith 2005). Introduced species (e.g. common carp, Nile tilapia, and silver barb), which are commonly used in aquaculture, require a higher level of management than native blackfish, which are essentially amphibious and do not require oxygenated water to survive. Unlike rice-field fishery, culture fisheries are often privately owned and accessed. In larger bodies of water, communities must agree on management and access rights. Discussions with Fisheries Committee members from both the Kamping Pouy and Boeng Sne Irrigation Schemes (de Silva and Senaratna-Sellamuttu, this study) indicate that the reservoir fisheries in both schemes have declined significantly, due to challenges of resource governance. According to Thuon et al. (2007), if wild capture fisheries are affected by agricultural intensification, attempts to compensate by developing aquaculture will also face impediments related to landholding size and location, but may tend to shift the workload onto women and children.

Conclusions

Gains from intensification of rice production need to offset the potential loss of rice-field fisheries to be beneficial in aggregate terms. However, the comparison is not a simple economic equation. Benefits from intensification of rice accrue to individual (mainly large scale) farmers, while rice-field fishery is mainly a common pool resource, providing a range of social and environmental benefits, especially for households less endowed with other productive assets. Which groups gain and loose as these systems are modified also emerges as a central concern considering the government's stated poverty reduction commitments. Thus, measures to mitigate loss of rice-field fishery must go beyond considerations of productivity, and address the social distribution of benefits, as well as the wider environmental implications.

Questions for further research

Different rice culture systems are being promoted that involve different water management practices. What implications are these altered hydrological regimes likely to have on rice field fisheries? How will they affect migratory practices? What is the potential for co-culture? To what extent could reservoir fisheries compensate for any negative impacts? Is there potential for efficiency gains in water management to help save some water for reservoir fisheries?

Another source of impacts on fisheries linked to rice intensification is the increase of chemical inputs that generally accompany intensified production. What is the current scenario with respect to their impacts on aquatic biodiversity associated with rice fields and human health, and trade-offs against any gains in yields? What measures and practices are available to minimize these tradeoffs?

The governance of fisheries, whether in rice fields or reservoirs, remains open-access and laissez-faire in nature. Ensuring a more sustainable and equitable management of these resources requires collaboration between different government agencies as well as resource users and other local actors. What mechanisms can best facilitate such an outcome?

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