10. Experiences of Various Countries

As far as can be ascertained from the available literature, rice-fish farming is still practiced in quite a few countries as shown in Figure 20. There are no hard statistics on the total extent of rice-fish farming globally but estimates for the major countries are available (Table 17). The world’s rice-fish farms are concentrated within South Asia, East Asia and Southeast Asia but there are also some notable developments in Africa. This chapter mainly provides a historical perspective and reports on the current status in major regions.

10.1 East Asia

China

China, with 27.4 million ha of rice land, is second only to India in terms of hectarage but is first in terms of rice production with about 166 million t.\textsuperscript{19} It is the world’s largest aquaculture producer with an inland production of 28 million t,\textsuperscript{20} and rice-fish culture has always been given a strong emphasis in China. It also has the oldest archaeological and documentary evidence for rice-fish farming.

However, it was not until after the founding of the People’s Republic of China in 1949 that rice-fish culture developed quickly in the whole country. In 1954 it was proposed that development of rice-fish culture should be spread across the country (Cai et al. 1995a), and by 1959, the rice-fish culture area had expanded to 666 000 ha. From the early 1960s to the mid-1970s there was a temporary decline in rice-fish farming. This was attributed to two developments: first, the intensification of rice production that brought with it the large-scale application of chemical inputs; and second, the ten-year Cultural Revolution (1965-75) during which time the raising fish was considered a bourgeois way of making money and was officially discouraged.

Improved rice varieties, use of less toxic chemicals and political changes (production-contract or production responsibility system) reversed the earlier trends of the 1960s and 1970s. The new

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\textsuperscript{19} FAOSTAT data (2003).

\textsuperscript{20} FAO FISHSTAT data (2002), excluding aquatic plants.
system allowed individual families, rather than the commune, to become the main production units. In addition, the rapid development of aquaculture required a large supply of fry and fingerlings. This demand was partly met by fingerling production in rice fields.

In 1983, the Ministry of Agriculture, Animal Husbandry and Fisheries (now the Ministry of Agriculture) organized the First National Rice Fish Culture Workshop. The workshop resulted in the establishment of a large coordination group for Eastern China to popularize rice-fish farming techniques. Also various other provinces, autonomous regions and municipalities undertook such measures in line with local conditions. As a result, by 1996 China had 1.2 million ha of rice-fish farms producing 377 000 t of fish (Halwart 1999).

Thus it can be seen that in China rice-fish farming is promoted actively as a viable option for rice production. It is part of the program not only of fishery institutions, but also of agencies involved in rice production. In addition, it receives considerable support at the ministerial level of government.

Japan

Rice-fish farming appears to be of minor importance in Japan and there is not much literature on the subject. After reaching a peak production of 3 400 t in 1943 due to war-time food production subsidies, carp production in rice fields decreased to only 1 000 t during the 1950s. In 1954 only 1% of Japan’s 3 million ha of rice land was used for carp culture (Kuronoma 1980) and it is no longer practiced on a significant scale if at all (Pillay 1990).

Korea

In Korea, rice-fish farming started only in the 1950s and never spread widely because the fish supply from inland waters was sufficient to meet the limited demand for freshwater fish (Kim et al. 1992). Inland production accounted for only 1.7% of the total fish production of 3.3 million t in 1987. As of 1989 only 95 ha of rice fields were being used for fish culture, and only for the growing the most popular species of loach (Misgurnus anguillicaudatus).

10.2 Southeast Asia

Indonesia

Rice-fish farming is believed to have been practiced in the Ciamis area of West Java, Indonesia, even before 1860 although its popularization apparently started only in the 1870s. Ardiwinata (1957) attributed the expansion of fish culture in rice fields to the profound changes in the governing system during the Preaenger regency in West Java in 1872, during which the possession
of rice fields was made hereditary. The pressure on the arable land by the growing population caused the rental rates to go up. Tenants started to utilize their fields by stocking fish, generally common carp, or by raising other crops. Fish culture was popular because the capital required was minimal, and the landowners did not expect a share of the fish. This practice is what is called palawija or fallow-season crop.

The spread of palawija outside its point of origin in Java is attributed to the Dutch administrators who promoted the concept. By the 1950s some 50 000 ha of rice land were already producing fish. The development of irrigation systems also contributed to the expansion of the area used for rice-fish farming. The average area of rice-fish farming increased steadily after Indonesia became independent in 1947 and rice-fish farms covered 72 650 ha in 1974, but declined to less than 49 000 in 1977. The decline was attributed, ironically, to the government's rice intensification program (Koesoemadinata and Costa-Pierce 1992). However, the surging demand for carp fingerlings brought about by the proliferation of fish cages in dams and reservoirs stimulated expansion once again. The area utilized reached an all time high of 138 000 ha in 1982, but declined to 94 000 ha in 1985.

Recent reports indicate that rice-fish farming is on the upswing. The 1995 figures from the Directorate General of Fisheries indicate a total area of over 138 000 ha. The resurgence has been attributed to a drastic change in rice production practices in 1986 when integrated pest management (IPM) was declared the official national pest control strategy. At present rice-fish farming is practiced in 17 out of 27 provinces in Indonesia. In summary, the development of rice-fish farming can be attributed to landless tenants who wanted an extra income during the fallow season for rice. The government's rice intensification program, promoting heavy use of chemical pesticides, was the major reason for its decline in the early to mid-1970s. Its growth at present has been attributed to the increased demand for fingerlings to stock fish cages, which makes it a purely market-led development.

**Thailand**

Integrated rice-fish farming is believed to have been practiced for more than 200 years in Thailand, particularly in the Northeast where it was dependent upon capturing wild fish for stocking the rice fields. It was later promoted by the Department of Fisheries (DOF) and expanded into the Central Plains. The provision of seed fish and technology helped in popularizing the concept. Rice yields in rice-fish farms in the 1950s increased by 25-30% and the fish yields ranged from 137 to 304 kg·ha⁻¹·crop⁻¹ (Pongsuwana 1962). As a measure of the importance given to rice-fish farming, the DOF established a Center for Rice-Fish Farming Research in Chainat in the Central Plains in 1968. However, during the 1970s, Thailand, like the rest of Asia, introduced the HYVs of rice and with it the increased use of chemical pesticides. This resulted in the near collapse of rice-fish farming in the Central Plains as farmers either separated their rice and fish operations or stopped growing fish altogether. In 1974 the research center in Chainat was closed.

However, rice-fish farming did not completely vanish and in recent years it has recovered, particularly in the Central Plains, North and Northeast Regions. In 1983 rice field culture fisheries was practiced on 2 820 ha mainly in the Central, North, and Northeast Provinces. This grew to 23 900 ha in 1988 and was further expanded to 25 500 ha in 1992. Such a steep increase resulted from a general decrease in the availability of wild fish made worse by the occurrence of the ulcerative disease syndrome in wild fish stock. Fedoruk and Leelapatra (1992) attributed the recovery to more discriminate use of HYV; the emergence of pesticides that when properly applied are not toxic to fish; the growing perception of the economic benefits of rice-fish farming, and its promotion in special projects assisting disadvantaged farmers, among other factors.

Little et al. (1996) concluded that the development of rice-fish systems is unlikely to be homogeneous in the Northeast Region. The high expectations of farming communities is thought to be a major constraint to the wider adoption of rice-fish systems where off-farm employment was the norm as the major means of livelihood until the economic crisis in mid-1997. The increasing frequency of directly broadcasting rice seeds and using machines for field preparation are signs of the growing labor shortage. The shortage may favor the development of more easily managed pond culture rather than the more laborious rice-fish system. On the other hand, adoption of rice-fish systems in the Northeast Region may be biased towards those who are betteroff and have access to labor and other resources.
Malaysia

In Malaysia, from where reports on the practice of rice-fish farming appeared as early as 1928, the rice fields have always been an important source of freshwater fish. Before the 1970s when farms still practiced single-cropping, integrated rice-fish farms were the major suppliers of freshwater fish, especially for snakeskin gouramy (T. pectoralis), catfish (Clarias macrocephalus), and snakehead (Channa striata). Fish production from rice field started to decline with the introduction of the double-cropping system and with it the widespread use of pesticides and herbicides (Ali 1990).

Vietnam

Vietnam has a strong tradition of integrating aquaculture with agriculture. The Vietnamese system involves the production of livestock, vegetables, and fish in a family farm and does not necessarily involve rice. While fish, shrimps and other aquatic organisms were traditionally caught in the rice fields, these were reported to have become scarce ever since chemical pesticides started to be used (Mai et al. 1992). Le (1999) reports five common rice-fish culture systems being practiced in Vietnam, but gives no figures on the area involved. The five systems are fish-cum-rice for nursery and growout, fish-cum-rice for growout only, shrimp-cum-rice, fish/rice rotation and shrimp/rice rotation.

The Philippines

In the Philippines, fish are traditionally allowed to enter the rice fields with the irrigation water and are later harvested with the rice. The earliest mention of stocking fish in a rice field in the Philippines was made in 1954 (Villadolid and Acosta 1954), but it was not until 1974 when rice-fish farming became part of a research program of Central Luzon State University (CLSU). In spite of the lower rice yields (on average 3.8%), in 1979 the government proceeded to promote rice-fish farming nationwide. The decision was based on the results of the economic analysis that even with a reduced rice production, the farmer would still be economically ahead due to the additional income from the fish. After a peak of 1 397 ha involving 2 284 farms in 1982 the program was discontinued in 1986. At that time it covered only 185 ha (Sevilleja 1992) despite the fact that the average production of rice from rice-fish farms was above the national average.

Sevilleja (1992) did not offer any explanation for the sudden drop in the participation by 1983; however records show that 1983 was one of the worst El Niño years in recent history and the drought badly affected agriculture (Yap 1998). The year 1983 also marked the start of political turmoil and relative politico-economic stability did not return until 1990. The failure of the rice-fish promotion in the Philippines should also be viewed against the political milieu. In 1999, a more modest rice-fish program was launched.

10.3 South Asia

Rice-fish farming is known to have been practiced in India, Bangladesh and Sri Lanka and much of the history, current practice and potential is highlighted by Fernando and Halwart (2001) in their paper on fish farming in irrigation systems with special reference to Sri Lanka.

India

Having the world’s largest area devoted to rice cultivation at 42 million ha as of 1994, India produces a considerable amount of fish from its rice fields. A report on the status of rice-fish farming in India (Ghosh 1992) indicates that India has rice-fish farms covering 2 million ha, which is the largest reported area for rice-fish culture for a single country. Rice-fish farming is considered an age-old tradition in the states of West Bengal and Kerala, but it is limited to capture systems in the Ganges and Brahmaputra plains.

The practice cuts across different ecosystems, from the terraced rice fields in the hilly terrain in the north to coastal pokhali plots and deepwater rice fields. In between are the mountain valley plots of northeastern India and rainfed or irrigated lowland rice fields scattered all over India. The species involved are just as diverse with over 30 species of finfish and some 16 species of shrimps listed as being cultured in Indian rice fields. Most of the non-carp species and penaeid shrimp species are from natural stocks entering the rice field with the flood waters. Production rates are varied, ranging from 3 kg·ha⁻¹·year⁻¹ in the deepwater rice plots relying on natural stock of mixed species to over 2 t·ha⁻¹·year⁻¹ of Tiger shrimps (P. monodon) in shallow brackish water rice fields (Ghosh 1992).

Bangladesh

Farmers in Bangladesh have been harvesting fish from their rice fields for a very long time.
The description of the traditional practice in Bangladesh that follows came from Dewan (1992). Farmers construct ponds of different sizes in low-lying areas of the field and when the ponds and rice fields are full of water during the monsoon, carp fry are released, following no specific stocking density. The small ponds may be provided with brush shelters, but no fertilizers or feed are applied. The fish are harvested over a period extending from the time the rice is harvested in November-December up to March. In the coastal areas, marine shrimps such as the various penaeids including *P. monodon* may also be cultured. The traditional bheri system is used wherein the rice fields are enclosed by small embankments complete with inlet channels and sluice gates. Fields vary in size from 3 to 50 ha. Both rotational and concurrent systems are practiced. Occasionally, the freshwater prawn (*M. rosenbergii*) may also be cultured. Prawn fry gathered from nearby rivers are stocked after the monsoon rains have washed out the salinity from the rice fields.

Intensive studies and surveys undertaken from 1992 to 1995 in Bangladesh showed improvement in income and food availability for most of the respondents to the extent that 89% of the farmers involved planned to continue with the practice (Gupta et al. 1998). CARE-Bangladesh promoted rice-fish culture in all its projects as an integral part of its IPM strategy (Nandeesha and Chapman 1999).

Bangladesh is one of the few countries actively promoting rice-fish farming and pursuing a vigorous research and development program. NGOs in Bangladesh are likewise showing increasing interest in rice-fish farming. Among the more successful NGO efforts was the Noakhali Rural Development Program in 1989 which used the rotational system to produce from 223 to 700 kg ha\(^{-1}\) of mixed species of fish in 50 fields planted with local rice varieties (Haroon et al. 1992). More recently, CARE has become the most active NGO involved in rice-fish farming.

Thousands of farmers in Bangladesh have experimented with rice-fish culture and have developed practices to suit their own farming systems. Both table fish and fingerlings are being produced with farmers generally concentrating on fish seed during the dry season, which is an irrigated crop. The adoption rate among the project participants has been in the range of 10-40% depending on the area and sex of the participant. Initially the adoption rate was lower among females, but the activity is reported to be gaining popularity among both male and female groups. Increased income and fish consumption have been noted among families adopting rice-fish culture in Bangladesh.

**10.4 Australia**

A large commercial rice grower in Newcastle, New South Wales is stocking common carp in rice fields on a trial basis. The intention is to eventually stock 5,000 ha with common carp on a concurrent basis with rice. The fish produced will be used as raw materials for pet food (personal communication, Mr. Jonathan Nacario, Consultant, 12 October 1999).

**10.5 Africa, Middle East and West Asia**

Apart from Egypt, Africa has 10 rice producing countries with a total rice land area of 6.8 million ha. Nigeria has the largest rice area with 1.7 million ha, followed by Madagascar and Guinea with 1.2 million ha and 1.1 million ha, respectively. In terms of rice production Nigeria is first with 3.8 million t, followed by Madagascar with 2.36 million t.

**Madagascar**

The earliest report on rice-fish culture in Africa comes from Madagascar. As early as 1928, Legendre (cited in FAO 1957) reported on the practice in Madagascar on the culture of *Paratilapia polleni*, *Carassius auratus* and *Cyprinus carpio* in rice fields. This was followed by another report in 1938 on poultry-raising and fish culture in rice fields. Based on the report of Coche (1967), the level of technology in Madagascar at that time appears to have approximated that of Asia, although stocking was lighter. Both concurrent and rotational systems relying on entry of natural fish stock were practiced. In 1952 the government initiated a program to promote fish culture in fishponds and rice fields. Local capacity in the mass production of fingerlings was developed in 1972. Only in 1979 was sufficient progress made for the government to promote rice-fish culture. Fingerling supply remained a major constraint until 1985 when the government promoted private sector participation in fingerling production. By the end of the 1980s it was realized that without continued external assistance the government would be unable to sustain the operation (Van...
An average yield of 80 kg·ha\(^{-1}\) indicates that culture techniques at the farm level still need to be improved (Randriamaiana et al. 1995).

A country with almost 900 000 ha of rice fields does have a great potential for rice-fish farming, as about 150 000 ha could be suitable for rice-fish farming. A potential annual production of 300 000 t of edible fish has been projected from the said areas. Rice-fish culture in Madagascar was significant enough to be mentioned in a country study done by the US Library of Congress (Metz 1994).

**Malawi**

Farmers in Malawi are just beginning to grow rice and fish together as well as fish and vegetables. Although not specifically mentioned, the fish involved are apparently tilapia, where O. shiranus and/or T. rendalii are reportedly the principal species in the country.

**Zambia**

Rice-fish culture trials have been reported for Zambia by Coche (1967) but failed to take off. In 1992-93, FAO again introduced the concept during the implementation of the Aquaculture for Local Community Development Programme (ALCOM). Although the project was discontinued when economic analysis showed that income from the fish and the additional rice harvested failed to compensate for the additional cost of culturing fish, many farmers continued with the practice on their own (Nilsson and Blariaux 1994).

**Senegal**

In Senegal, low-land farmers have resorted to integrating fish culture with rice farming due to environmental changes that endangered their rice farms (Diallo 1998). Seawater encroaching on their rain-fed coastal rice fields forced them to build fishponds to prevent tidal waters from inundating their rice fields. In the process they also produce fish.

**Other African Countries**

Congo-Katanga (now known as Shaba province of the Republic of Zaire) and Rhodesia (now Zimbabwe), Ivory Coast, Gabon, Liberia and Mali and Benin are reported to have conducted rice-fish culture trials (Coche 1967; Nzamujo 1995; Vincke 1995). More recent activities for West Africa have been documented by Moehl et al. (2001). Integrated aquaculture trials have been limited to fish with only livestock in both Cameroon (Bréne et al. 1995) and Rwanda (Verheust et al. 1995).

**Egypt**

Egypt, which is the biggest rice producer in both the Middle East and the African continent, started with a capture-type of rice-fish farming based totally on occasional fish stock coming in with the irrigation water. Limited experiments using carps in the early 1970s were conducted with encouraging results (Essawi and Ishak 1975). The rice-fish farming area expanded considerably using reclaimed salt-affected lands and in 1989 reached a peak of 225 000 ha. As rice prices increased, however, HYVs were adopted and reclaimed lands were used for rice monoculture. This resulted in a drop in the rice-fish area to 172 800 ha by 1995. Nonetheless the 1995 fish production from rice fields accounted for 32% of the total aquaculture production in the country (Shehadeh and Feidi 1996). Since then 58 000 ha of farmland have been added producing 7 000 t of C. carpio in 1997 (Wassef 2000).

**Iran**

Iran begun rice-fish culture trials in 1997 (personal communication, Mr Ibrahim Maygoli, Shilat Aquaculture Division Head, Tehran, Iran, 30 August 1999). With good results obtained, 18 farms with a total area of 12 ha adopted the technology. Chinese major carps are used concurrently with rice, sometimes with supplementary feeding. Productions over 1.5 t of fish per ha together with 7 t of rice have been achieved with a high survival rate (96%), despite an average water temperature of only 23°C during the culture period. In addition, 70 farms have adopted a rotational rice-fish farming system where the rice field is stocked with trout during the winter months when the average water temperature is 12°C, yielding 640 kg·ha\(^{-1}\). Concurrent culture of M. rosenbergii with rice is also being tried.

**10.6 Europe**

Rice is not a major crop in Europe and is relatively important only in Italy (216 000 ha of rice land) producing 59% of the European Union’s (EU)
rice production. Spain with 86,000 ha comes a distant second, contributing only 25% of the EU production. The other European countries producing rice are Albania, Bulgaria, France, Greece, Hungary, Macedonia, Romania, and Yugoslavia.

Italy

Rice-fish culture was introduced to Italy at the end of the 19th century and was to progressively become important during the subsequent 40 years. The main species were C. carpio, C. auratus and Tinca tinca. The rice fields were used to produce fingerlings that had a ready market among pond owners and angling society. The practice gradually declined and by 1967 it was no longer considered an important activity. The cause of its decline was traced to economic, social and technical factors. As rice farmers abandoned traditional practices to increase rice production, the production of fish became less and less compatible with these new practices (Coche 1967). There is a renewed interest in investigating fisheries management in rice fields including ecological and economic aspects under modern methods of cultivation at the University of Bologna.

Hungary

In Hungary where irrigated rice land once covered 45,000 ha, C. carpio was cultured in the flooded fields by the cooperative and state farms to reduce production costs. In the absence of marine fish, freshwater fish commanded a good price thus boosting the farmers' income. It was also reported that fish helped keep the fields clean. With the total rice hectarage down to only 5,000 ha as of 1992, there is no published information as to whether any of the rice fields are still cultivating fish.

10.7 The Former Soviet Union

Although wheat is the most important grain for most of the former Soviet Union countries, rice is grown in some of the Central Asian republics and many have tried or practiced rice-fish culture.

Fernando’s et al. (1979) listing of publications dealing with the aquatic fauna of the world’s rice fields had 55 entries from the former Soviet Union, of which 12 dealt specifically with rice-fish culture. This is a large number considering that the bibliography had a total of 931 entries from 61 different countries and territories. By way of comparison the US had a total of 70 papers listed, 89 for India, and 54 for Japan.

The most authoritative historical review for this region is by Melen (1940).

10.8 South America and the Caribbean

Although rice is produced in nine countries in South America and eight countries in the Caribbean, the culture of fish in rice fields is not widespread. As early as the 1940s, experiments were being conducted in Argentina on the culture of kingfish (Atherina bonariensis) in rice fields as a food fish and for the control of mosquitoes (Macdonagh 1946 as extracted from FAO 1957). Attempts were also made to introduce the concept in the British West Indies and the British Guiana in the early 1950s (Chacko and Ganapati 1952 as extracted from FAO 1957).

Experiments on integrating fish culture with rice production are, or were, being conducted in Brazil, Haiti, Panama and Peru, but only Brazil appears to have had some degree of commercial success. Extensive rice-fish culture had its beginnings in the valley of Rio São Francisco (northeast) and in the rice fields in the south. In the northeast, farmers became interested in semi-intensive rice-fish culture using native fish species caught in lakes along the river such as curimatá pacu (Prochilodus argentes), piau verdadeiro (Leporimus elongatus), and mandiarnarelo (Pimelodus clarias). Experiments on intensive rice-fish culture were also conducted in the Paraíba basin using the C. carpio and Congo tilapia (T. rendalli) (Guillen 1990). The outlook for rice-fish culture is thought to be favorable for the region because of its suitable climate and irrigated areas. Recent FAO-facilitated community work focuses on the promotion of aquaculture and other integrated production methods in rice-based systems in Guyana and Suriname.

10.9 The United States

Rice-fish farming used to be considered important in the United States. After the rice had been harvested, the rice lands were flooded and stocked mainly with C. carpio, bigmouth buffalo (Ictiobus cyprinellus), and channel catfish (Ictalurus punctatus). In 1954, some 4,000 ha of woodlands in Arkansas were diked, flooded, and stocked
with fish. In 1956 this increased to 30 000 ha and reportedly produced 3 200 t of fish. Demand for fingerlings shot up and new hatcheries had to be put into operation.

The growing importance of rice-fish farming and the need to improve existing practices led the US Congress to enact the Fish Rice Rotation Act of 1958 for the Secretary of the Interior (who then had jurisdiction over the Fish and Wildlife Service) to implement. Its objective was “to establish a program for the purpose of carrying on certain research and experimentation to develop methods for the commercial production of fish on flooded rice acreage in rotation with rice field crops, and for other purposes.” To carry out the studies on rice-fish rotation a research station, which was to become the Stuttgart National Aquaculture Research Center (SNARC), was established in Stuttgart, Arkansas.

By 1960, a survey of 53 selected farmers in the states of Arkansas, Louisiana and Mississippi showed that 20.4% of the total water surface area was used for fish culture. At that time there were 1.25 million ha of irrigated rice lands in the US and the potential for fish culture was considered great. Coche (1967) thought the industry had bright prospects, saying, “There is little doubt that a new area of intensive development can be forecast for fish culture in the vast complex of US rice fields.”

As technology evolved and because of new economic realities, interest in rice-fish farming appears to have waned sometime after the 1960s. This can be surmised from the shift in the research direction of SNARC.

Nonetheless, the concept of fish-rice rotation on a commercial scale is far from dead in the US. However, instead of finfish, crawfish are now being rotated with rice. Two crawfish species are popular because of their hardness and adaptability, the red swamp crawfish (Procambarus clarkii) and to a certain extent the white river crawfish (P. zonangulus). The life-cycle of crawfish and environmental requirements lend very well to being rotated with rice and even with rice and soybeans. Most of the crawfish produced in the US now come from the rice fields of the southern states (De La Bretonne and Remaire 1990).