Field Actions Sci. Rep., 2, 49–56, 2009
www.field-actions-sci-rep.net/2/49/2009/

FACTS Reports

Rice-fish farming in Guinée Forestière – outcome of a rural development project

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Abstract. The rice-fish farming project in Guinée Forestière launched in 2000 was, at the outset, a pilot project for the purpose of testing the introduction of a new production technique in an impoverished and land-locked region. It aimed to improve food security for people living in the region and to promote the creation of income through a diversification of activity and better land use. The intervention strategy followed the template used in Côte d'Ivoire for a similar project. It consisted in supporting groups of voluntary producers who were ready to accept the risk of financing lowland developments to produce fish and rice. The project was supported by a small group, mainly composed of volunteers (expatriates) and local facilitators recruited as the project activities progressed. A € 1.8 million grant was donated by the Agence Française de Développement, raised between 2000 and 2008, to cover technical assistance and training expenditures.

The project gave precedence to the concept of actor autonomy for the development of lowlands and ponds.

Investments were financed and implemented by the producers themselves depending on their available resources in funds and labour. Animal husbandry methods, based on extensive mixed cropping, used no other inputs than those available on the farm itself. The fish farmers themselves supplied alevins.

To ensure the sustainability of rice-fish farming activities after the project ended, special emphasis was given to providing a structure for the profession in the future by encouraging the members of the groups to sponsor and train new candidates.

Although results exceeded the initial targets since, by the end of the project, 350 farmers and 500 ponds were active, lowland rice and fish production is still limited. It does provide, however, regular supplies of fish to approximately 6000 people, calculated according to the low level of local consumption (10 kg/per year/per person).

The impact of the project is considerable. In economic terms, lowland development is an excellent profit opportunity since it multiplies farmers' incomes by six, two thirds of which are from fish farming and the remaining third by rice. The lowland development technique reduces the time required to cultivate rice by 30%. As a result, these benefits are attracting a large number of new potential entrants.

The impact on the environment is also positive, in particular due to the improvement of soil fertility and the beneficial effects of ponds on the natural environment.

Finally, these good results have led to plans for new projects to prolong and consolidate existing benefits and to repeat the system in other countries.

1 Introduction

The rice-fish farming project was launched in Guinée Forestière in 2000. It was based on a similar project a few years earlier in the central westerly area of Côte d'Ivoire. Both projects were financed by the Agence française de développement. At the end of these eight years, some lessons can be drawn and these are outlined in the present report, which was written following a field assignment by one of its authors in October 2008, who had also been the author of the project ten years earlier.

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Published by Copernicus Publications on behalf of the Institut Veolia Environnement.

2 Project context

2.1 Conditions favourable to fish farming

Due to its geographical characteristics, Guinée Forestière has good potential for the development of fish farming combined with agriculture.

This long-standing forested area[1] is abundantly and regularly rainfed for eight to ten months in the year. The lowlands cover approximately 15% of the agricultural area and are, for the most part, usable with a potential estimated at 3000 hectares (Nga Thot Ingénieurs conseils, 2007). The region's agro-climatic characteristics are well suited to fish farming because of the presence of permanently standing bodies of water in a large number of valleys, the water's warmth, the amount of sunshine it receives and the short dry seasons.

Over 600 km away from Conakry, the country's capital and principal port, Guinée Forestière is particularly land-locked. The road network is in poor condition and supplies of consumer goods, agricultural inputs and equipment are costly and uncertain. Public utilities are not very efficient and farm advisory teams are not sufficiently well trained to give satisfactory support to farmers, particularly as regards fish farming which is seen as a new type of activity.

Population growth in Guinée Forestière is high. The population in the area is evaluated at over one million five hundred people, 78% of which live in rural areas. The proximity of Sierra Leone and Liberia, where there were civil conflicts in the 90s, means that a high proportion – evaluated at 40% in 2001 – of the population would seem to be even now composed of refugees (CIRAD-HCR, 2001).

The region's demography has had a severe impact on the agricultural production systems which, traditionally, were based on hillside slash-and-burn rice cultivation. With land reserves running out, farmers were obliged to intensify and turned to hillside cash crops, coffee in particular, and to systematic use of lowlands for rice cultivation. Before the project started, there was practically no fish farming anywhere in the region. A few roughly excavated pools where farmers kept fish they had caught in the backwaters met with little success and mostly fell into disuse.

2.2 Strong demand for animal protein

Fish is a staple foodstuff in West Africa. It is sold frozen, dried or fresh. FAO evaluates at 22% the dietary protein contribution of fish in this part of Africa[2]. In the poorest countries, this proportion sometimes exceeds 50%, in particular in areas where other animal products are rare and costly. In the West African coastal countries, the animal protein contribution of fish is high: over 60% in Guinea, Senegal, Ghana and Liberia.

In Guinea's forested region, protein deficit is the foremost dietary deficiency affecting the poor. Bushmeat is increasingly hard to come by and beef (from Upper Guinea), chicken and pork (produced locally) are sold at twice or three times the price of fish in local markets. The consumption of fish, which is the main protein dietary contribution in the area, is estimated at 10 kg per head per year. It is below the national average of 22.5 kg/head/year.

The nutritional value of fish eaten in the region is mediocre. The frozen sea fish which makes up the major part of available resources (about 90%) (Oswald and Blanchet, 2001), arrives only after numerous breakdowns in the cold chain caused by road blocks in the rainy season and uncertain, defective or even inexistent supplies of fuel and electricity. Smoked fish deteriorates rapidly when ambient humidity is high. Fresh fish, however, is more often than not sold live, at the same price as frozen fish. In the circumstances, local consumers much prefer to buy fresh fish, so that from the start of the project there was a potential market for fresh fish which only needed to be developed.

3 Pilot project

3.1 Issues at stake

In a poor, rural, landlocked environment, bereft of any effective public support, the project's end purpose was fighting poverty, but there were two complementary objectives: firstly diversifying farming activities to improve the level of monetary income; secondly, a sustainable increase of the local supply of both fish and rice[3].

The project strategy rested on the farmers' capacity for initiative and risk-taking[4]. As a counterpart, the project offered a technique for lowland fish farming, easily acquired because of locally acceptable investment levels. The technique was to be extended via a training project and support for locally recruited groups of volunteers.

There were, however, at the outset, a number of unknowns regarding in particular the degree of acceptance of this activity by farmers, the possibility of integrating it into existing farming systems and the magnitude of its economic, social and environmental effects. For these reasons, the project's initial objectives were limited: only 80 rice and fish farming units in some twenty villages were planned. It could therefore be viewed more as a pilot project aiming to demonstrate the feasibility of lowland rice-fish farming than as a full-scale project.

[1] Guinée Forestière is situated at the western end of the large Guinea-Congolese rain forest. This natural site includes seven administrative units (*préfectures*): Kissidougou, Gueckédou, Macenta, Beyla, Lola, N'Zérékoré and Yomou.

[2] Fish and Food Security in Africa, WorldFish Center, Penang (Malaysia), 2005.

[3] At the beginning, the project was mainly focused on fish production.

[4] The object of AFD's 1999 project was "to check if techniques and organisation" of rice-fish fish farming were adaptable.

Figure 1.

3.2 Grant financing

In 1999, the project was granted € 1.8 million, donated to Guinea by the Agence française de développement, for the 2000–2008 period. By the end of the project in June 2008[5], the grant was fully disbursed.

Most of the costs involved were for technical assistance[6], leadership and training for fish farmers.

On-site development was entirely at the expense of beneficiaries.

3.3 A restricted team to help farmers

Building on the experience acquired in Côte d'Ivoire, the same project management and farmer support system for fish farmers was used. It involved AFVP (*Association française des Volontaires du Progrès*), in partnership with APDRA-F (*Association Pisciculture et Développement Rural en Afrique – France*). The team's composition was as follows: a Project Leader, an executive from the Fisheries Ministry (corresponding to the Guinean government's compensation, two volunteers and local team leaders. The project provided for the recruitment and training of these team leaders. Recruitment increased gradually in step with the growing number of candidates for the new activity, starting with two team leaders and rising to eight by the end of the project. A female team leader was also included in the team to provide support for the wives of fish farmers working on the family farm. As the owners of the land were the men, only a few women, widows generally, were able to participate in the activity. For leadership in the more remote areas, the project outsourced to a service provider, INADER[7].

4 Promotion of an independent farming system

4.1 Turning lowlands into fish farming ponds

The ponds are dug manually and gravity fed; therefore no pumping is required. Construction is limited to digging a dike perpendicular to the flow of water in the lowland. The barrier created by the dike retains water upstream covering between 0.2 and over 1 hectare, with an average surface of 0.3 hectares per production pond. A service pond for the production of alevins must also be constructed. A moulded concrete monk type drainage system is built so that the volume of water behind the dam can be entirely drained off and the fish farmer can regulate the water level, in particular for rice cultivation and to harvest all the fish once the pond is emptied. An overflow outlet is also needed to evacuate excess water in the event of flooding which is frequent and sometimes violent in that part of the world.

The average cost of constructing a pond is equivalent to about € 1000 per hectare. For a 30 are pond, the total cost of investment including a 30 metre dike downstream, an intermediate dike and a by-pass channel with a 250 m^3 earth fill, is the equivalent of € 350, of which more than half is the cost of cement and tools and the remainder is for labour.

[5]However, due to non reimbursement by the Guinean government of its debt to AFD, disbursements stopped for a while, between June 2004 and August 2005.

[6]Not very expensive as mostly provided by volunteers.

[7]*Institut National pour l'appui au Développement Rural*, (National Institute for Rural Development Support, an NGO created in 1997, specialising in training and counselling).

Figure 2. Photo: D. Simon

Figure 3. Photo: D. Simon

To minimise cost, fish farmers enlist the help of members of the family or of a mutual-help group in the village. Or else, jobbers can be employed, in which case the expense is added to the cost of building materials and tools and a sufficient amount of money must be saved up before starting. Construction, which is often spaced out in time depending on the state of the fish farmer's finances, can take anywhere between two months and over a year. Some farmers stock their unfinished site with fish so that they can start production as quickly as possible, and use initial financial returns to complete construction.

4.2 Farming the pond

4.2.1 Polyculture

Mixed fishery is the recommended practice, with as the main species, tilapia (*Oreochromis niloticus*), reared together with heterotis (*Heterotis niloticus*) and catfish caught in the wetlands (*Heterobranchus isopterus*). Fish weight at the end of the cycle should be 250–500 gr. for tilapia, 1.5–3 kg for heterotis and 400–600 gr for catfish. So as to control the very

Figure 4. Photo: APDRA-F

prolific tilapia population and limit the reproduction of wild fish, a small carnivorous fish, hemichromis (*Hemichromis fasciatus*), is generally added to the production pond.

4.2.2 Stocking the ponds with alevins

So that the fish farmers can be independent, the project provides the initial generation of fish in each village or zone. Afterwards, the farmers themselves rear and produce the alevins in the hatchery ponds. In practice, although most farmers produce their own alevins, these are occasionally traded among villagers, which encourages the autonomy and sustainability of local production.

Sexing alevins, with the object of selecting the males, whose growth potential is higher, is done by farmers when they transfer the fish to the production pond.

4.2.3 Extensive breeding

At the outset, the possibility of adopting a semi-intensive breeding system was considered. But the idea was dropped almost immediately because a large working capital would have had to be mobilised to buy fish feed and farmers might have become over dependent on uncertain supply systems. Extensive breeding was therefore seen as more suitable for the local context in which the fish are fed free of charge by nutrients already present in the water. Furthermore, rice cultivation provides a natural source of enrichment through roots, stems and crop waste products. The farmers adapt fish density to existing environmental conditions. However, some intensification can be achieved if the ponds are fertilized with agricultural waste products (rice and maize bran) and animal husbandry waste (poultry droppings, liquid manure and cow dung, etc.).

4.2.4 Fish farming yields

Production cycles last six months and in practice, farmers can achieve two cycles per annum. Once the system is fully operational, yields are approximately one tonne per hectare per year. There are, however, important variations in the early years, depending on how well the farmer adapts to this new technique and masters the water level management or on the availability of waste products to top up feed for the fish. Harvests are made up of approximately 60% tilapia, 30% heterotis and 10% of other species (catfish, hemichromis).

4.2.5 Combining rice cultivation with fish farming

Generally, farmers produce one single annual rice growing cycle as against two fish crops. The main obstacle to a second annual rice growing season is a concentration of bird attacks on the rare grain crops available in the dry season. The losses are so high that they deter any new attempt at double cropping.

Rice yields per cycle total an average of 2 tonnes per hectare but can be as high as 4 tonnes. In contrast, in undeveloped wetlands, yields are never more than 1 tonne per hectare.

Rice cropping in developed lowlands involves a change in technique. The farmer empties his pond and replants seedlings immediately. Other work involved when growing crops in undeveloped lowland is no longer required: flooding obviates the need for clearing, the particularly strenuous work with the daba[8] is unnecessary. There is no need for weeding, except around the edges, because the pond eliminates weeds. Only harvesting is more difficult because it is done partly under water.

4.2.6 Agricultural calendar

Combined rice and fish cultivation fit very well into the farm's production cycle and the agricultural calendar as there is no overlap with other activities. Bedding the rice seedlings and the rice harvest take place simultaneously for rice grown in the pond and flooded rice grown in non developed wetlands. As for fish farming, dates for catching the fish are very flexible because production cycles can extend over six months or a year depending on each farmer's preferences and strategies regarding the size of the fish or need for income (feast days or beginning of school term, for example). Moreover, the sale and consumption of fish can be spread over the space of a month or two, since fish is stocked live in the service pond. This flexibility in the rice and fish production system and its efficient integration in other farming activities are assets which farmers appreciate.

[8]Traditional hoe used by farmers in the Sahel.

5 Organisation of the activity: a prerequisite for successful social dynamics

5.1 Central role of the fish farmer groups

The rice-fish farming activities sponsored by the project are only launched once a minimum of five candidates are identified in a village. This system of group support was chosen for three main reasons:

- grouping together, fish farmers form mutual-aid associations, facilitating the earthmoving work and thereby reducing investment costs and making more effective use of periods when farmers have time to spare;
- group leadership and training of farmers costs less and is more rewarding because members can benefit from discussion and interchange;
- the group helps the individuals concerned to gain more recognition in their village.

The project works as follows: once a month, a group leader stays a week in each village or zone. Group activity begins with a planning session in which difficulties encountered and specific training needs can be evaluated. In the course of the week, group and targeted training sessions are held. One of the system's strong points is that the group leaders stay long enough to strike up acquaintance with farmers, to hear of and understand their difficulties and build up trust. Training courses in the group are designed for easy dissemination since they will later be passed on by members of the group to new candidates through local networking. This method gives rise to supportive sponsorship provided by existing members to new farmers thus paving the way for acceptance of their help and advice.

For new candidates, the groups validates the application with an assessment of the technical and financial feasibility of the lowland development plan. The candidate then studies and defines the project, with the help of members of his group and advice from the group leader, preliminary to launching it. The group, assisted by the applicant's neighbours and the rural community, then verifies and validates the applicant's ownership of the land, so as to prevent any subsequent dispute.

Fish farmers' groups are in charge of training and also promoting and monitoring the services connected to the fish farming activity: manufacture of the monk drainage system, hiring of jobbers for earthmoving work. This local development work is useful to optimise sharing out of the alevins in the various ponds and to reduce the cost of equipment and local labour.

As mentioned above, one of the project's main objectives is to make the fish farming groups autonomous. They must acquire the qualifications enabling their members to provide the important leadership, training and assistance services that make the fish farming project sustainable once the project has

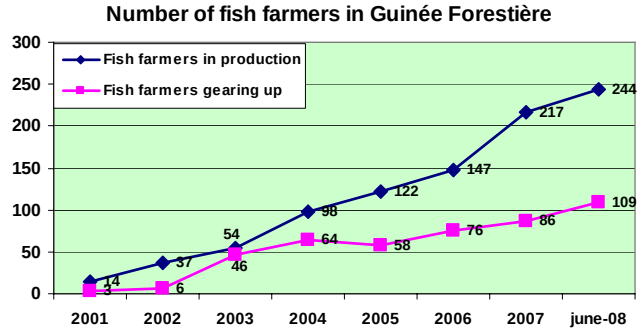

Figure 5.

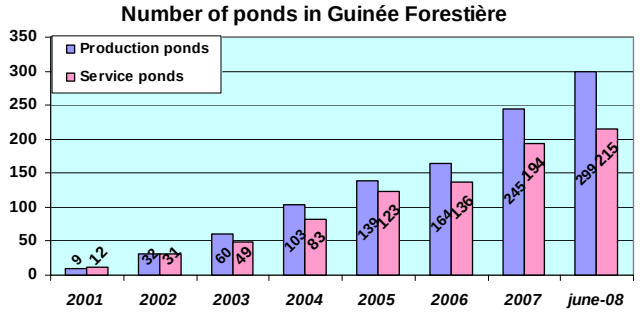

Figure 6.

ended. It is thanks to continuing support over time that the system can be fully effective.

5.2 Organisation of the activity

In 2004, the groups created the *Association des Pisciculteurs de Guinée Forestière* (APGF) (Fish Farming Association in Guinée Forestière). The 350 fish-rice farmers of the area are members. Through this association, fish farmers are in touch with national and foreign partners and can support the development of fish farming at a regional level. Contributions paid its members allow it to be supportive and representative. It now needs to reinforce its internal organisation, in particular as regards rallying new candidates and become, as it intends to be, a true motor force for the development of this sector.

6 Results and positive outcomes

Due to the project's innovative nature, start-up was slow. Farmers had to be persuaded to take the risk of branching out into this kind of production. Two years were spent on awareness-raising, but fish farming then started in earnest and initial expectations were more than met.

6.1 Encouraging the spread of rice-fish farming

On completion of the project, in June 2008, fish farming only prevailed in part of Guinée Forestière, mainly located in the N'Zerekore préfecture with an extension in Gueckedou. Out of the 350 fish farmers who were identified, 244 were already producing fish and 109 were gearing up. More than 500 ponds had been created over a 58 hectare area. Fish production is now 60 tonnes and rice paddy yields about 150 tonnes.

These results are encouraging. At the time of the 2008 mission, those in charge in the fish farmers association reported a large number – several hundred in fact – applications to set up new ponds and that this activity enjoyed a very favourable reputation in the villages. It seems reasonable to hope for a significant development of rice-fish farming in the next few years, thus substantiating the project's chosen intervention strategy and its financial dimensions.

6.2 On the path to food security for the local population

A third of the modest current production is self-consumed. The remaining two thirds are sold as fresh food in the home village and smaller quantities are sold further away. In October 2008, the price per kilo ranged from € 1 to € 1.7 for tilapia and € 1.7 to € 2 for heterotis. The price of deep frozen fish is much the same as for tilapia. The product of fish farms is therefore competitive.

Live fish, when it is sold away from the home village, is generally transported on bicycles or mopeds in water-filled cans so that they keep for several hours. In view of the quantities available for sale, this primitive system does not appear to be a limitation.

Altogether, fish production feeds 6000 people on the basis of a consumption figure of 10 kg per year. The number of fresh fish consumers would in fact be higher since frozen fish is still predominant. Therefore, as over 10 000 tonnes of frozen fish are sold annually in the region[9], the solvent demand for fresh fish is still largely unsatisfied. If the total 3000 hectares of lowland suitable for fish farming could be exploited, production would nonetheless only represent 25 to 30% of the quantity of frozen fish currently for sale.

7 High economic profitability and positive social impact

7.1 Profitability and productivity of farms

The project is highly appreciated by farmers because, added to the net benefits procured by the fish farming activity, there is a significant improvement in profitability and productivity in rice cultivation.

As Table 1 shows, development of lowland to create a rice-fish farm gives a farmer the possibility of multiplying his total income per hectare by six (equivalent to 1620 €/ha)

[9]Data evaluated on the basis of volumes transiting through wholesalers in N'Zerekore.

Table 1. Evaluation of average income generated per hectare with and without development.

	Units	Before the project	With the project
Rice yield	t/ha	1	2
Fish yield	t/ha	0	1
Unit price for rice	€/kg	0.28	0.28
Unit price for fish (weighted)	€/kg	1.06	1.06
Rice income	€	280	560
Fish income	€	0	1060
Total income*	€	280	1620

* On-farm consumption included

compared to the situation before development (280 €/ha), based on prudent evaluations of yields and prices. Two thirds of this income is derived from fish and one third from rice.

Apart from the major contribution made by fish production, these higher rice-fish farming yields are due mainly to three causes: doubling (or even multiplying by as much as five in some cases) rice yields, a significant improvement in the productivity of rice-growing and greater flexibility in the agricultural calendar.

The improved yields are mainly due to soil fertility regeneration as a result of the lowland development work. Fish farming ponds are most often set up at the head of lowlands in rather infertile areas initially which are then emended by the deposit of silt and other organic matter. Moreover, the consequent constant presence of a sheet of water reduces the destructive effects on crops of pests such as caterpillars, rats and agouti.

With development, the amount of time that needs to be spent in the rice field is reduced by 30%. Whereas undeveloped lowland rice cultivation requires 160 days/ha, only 110 days are needed with developed lowland. The men are spared clearing and ploughing tasks and the women no longer need to do weeding.

In fish farming, production and marketing works on a flexible timetable so that income can be earned when needed, including during the dry season. Combined with the lighter burden of labour for rice production, farmers are better able to manage their work schedules and limit the use of outside labour. They can, for example, spend more time on their coffee plantation.

With this kind of profitability, time for recovery of investment costs can be as little as under two years, particularly when the major part of the work can be done by the farmer's family or by the mutual support group. Time for recovery is of course dependent on how soon the pond can become fully operational. Once the pond production has reached its full potential, return on investment can be as a little as a year.

Finally, by creating and distributing additional income at village level and increasing the food supply, rice-fish farming gives villagers the possibility of emerging from the poverty trap caused by the fact that the region is landlocked. This applies to both men and women. Nevertheless, rice fish farming involve only land owners.

7.2 Effects on the environment and on health

7.2.1 Environmental impact

Despite a monitoring and evaluation system that still needs perfecting, the project has already provided some new insights regarding its effects on the environment.

Obviously, lowland development has a traumatic effect on the natural environment. However, in these areas which are subject to growing anthropic pressures and to repeated stress (constant cropping, bush fires), creating permanently watered sites gives a large number of species an opportunity to find a niche into which they can fit.

Even though the developments only concern the bottom of hillsides and valleys, they are a partial response to the downgrading of the environment apparent in this zone: deforestation, evidence of reduced rainfall, rapid succession of slash-and-burn cycles with, as a consequence, the appearance of savanna types of landscapes. As we have noted, the developments improve soil fertility in the lowlands, help to regulate the flow of streams and rivers and runoffs from the drainage basin, replenish the groundwater table and reduce the level of hillside soil exploitation.

Water storage during the dry season (underground near the ponds and in the pond itself) and its availability for agricultural purposes has many advantages: changing savanna to post-forest formation, protecting crops against fire, etc.

Nor is it impossible that much greater ecological complementarity exists between aquatic and hillside ecosystems than was previously thought. Whereas plateau cultivation is prone to phosphate deficiency, the pond ecosystem temporarily traps it, together with nitrogen. Finally, it should be emphasised that the deliberately extensive production strategy prevents any chemical pollution of the water.

7.2.2 Impact on health

To date, there has been no outbreak of diseases following the construction and launching of the ponds. In particular, the schistosomiasis (bilharzia) vector seems to be eradicated by heterotis populations even when it is present in neighbouring rice paddies. Mosquito larvae are eaten by tilapias. Pathogenic germs are eradicated because the ponds function like a constructed waste stabilisation system (in Côte d'Ivoire, contamination with salmonella when doubtful fertilisers were used, disappeared within two weeks). As ponds are systematically constructed so that they can be drained, when they are completely dry, pathogenic organisms including possible sources of disease which were contained in the

water, die off and the local environmental conditions can be restored.

8 Conclusions and potential

Based on a pilot project fraught with uncertainty, the rice-fish farming activity in Guinée Forestière has made satisfactory progress and encouraged a large number of applications from potential operators. Should the number of constructions continue to grow or even accelerate, the food security and income improvement objectives could be fully achieved. The strategy used for the project, that is based on self-supporting groups and training of new applicants by experienced farmers, would be validated.

The main issue to be resolved would be the fish farmers' and their professional associations' capacity to cope with an extension of the policy. In Guinée Forestière, three conditions would seem to be required to consolidate existing achievements:

- reinforcement of the professional associations of rice-fish farmers so that they can carry the policy forward beyond the term set for the project;
- reinforcement of research, monitoring and evaluation, and regional exchange programmes;
- continuation of the preference for systems which are sparing in their use of agricultural inputs so as to maintain the principles of self-support and ownership by farmers.

The economic, social and environmental advantages of rice-fish farming have encouraged several donors to take an active interest in this type of operation.

A new project supported by IFAD has been identified to prolong the action of the Agence française de développement in Guinée Forestière. Similar projects are under study or under way in Liberia, Sierra Leone and Côte d'Ivoire. Coordination of aid in this field is emerging.

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