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Socio-economic study of rice-fish farming in the region of upper Sassandra (Côte d'Ivoire)

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This study aims to assess the socio-economic impact of rice-fish farming in the Haut Sassandra region. To this end, a survey was conducted in five villages in the sub-prefecture of Bédiala between April and July 2020 using a questionnaire. The method of collecting data and other information consisted of direct interviews with the leaders of the Bédiala fish farmers' association (DEHIZEA), producers and fishmongers. The information thus obtained was supplemented by direct observations in the field. On the basis of the data collected on rice-fish farmers from DEHIZEA officials, 60 (or 30 %) rice-fish farms were selected out of 202 farms with effective fish farming activity in the areas concerned. The selection was made jointly with DEHIZEA officials using the simple random sampling method. The XLStat 2016 program was used to process the quantitative data. The results show that 63.3 % of rice-fish farmers are farmers and have been practicing the activity for more than 5 years. The sale of fish is the main activity of 80% of fishmongers. In 86.7 % of cases, rice bran constitutes the food distributed to the fish. The fish production of 40% of the rice-fish farmers is between 0.5 and 1.5 tonnes. Concerning rice production, 43% of rice-fish farmers produce between 500 and 1200 kg and 31% produce between 500 and 900 kg. On the other hand, all the rice-farmers have a production of less than 6 tonnes/year. They sell this production between 500 and 1000 CFA francs/kg, which gives an annual income of less than 5 million CFA francs. Ninety-seven percent of the producers are satisfied with the financial contribution of the system.
Keywords: Rice-fish culture, Socio-economic, Upper Sassandra, Côte d'Ivoire

INTRODUCTION

Aquaculture is for several million people throughout the world an activity of primary importance (FAO, 2020). In Côte d'Ivoire, its contribution to national fish production is about 2% despite the country's immense hydrographic potential (COMHAFAT, 2014). This production does not meet the national demand for fish products estimated at about 300,000 tonnes (MIPARH, 2004; FAO, 2016). The low contribution of aquaculture to the coverage of national fish needs is undeniably linked to the high production costs for fish farmers. The major constraint to the emergence of fish farming in developing countries is the cost of feed (Siddhuraju and Becker, 2003), which represents about 50% of the production cost of farmed fish (Slembrouck et al., 1991; Gourène et al., 2002). Moreover, Ivorian aquaculture is exclusively based on fish farming which is practiced in rural and peri-urban areas throughout the country (MIPARH, 2007).

To improve this contribution, the challenge is to develop a simple and inexpensive fish farming production policy, adapted to local agro-climatic and socio-economic contexts, with optimal use of natural resources (Hem et al., 2001). Thus, transferring techniques used effectively elsewhere such as integrated fish farming to a variety of cropping systems could be a solution (Halwart and Gupta, 2010). For example, China has become the world's leading country in fish production through the close union of agriculture and fish farming (FAO, 1980). Rice-fish farming, defined as the

integration of rice and fish farming for the simultaneous production of rice and fish on the same plot (Halwart and Gupta, 2010), is a perfect illustration of this model. This fish farming practice has been effective in the Upper Sassandra region since the 1990s.

The objective of this study is to investigate its socio-economic impact in this region. It will assess the socio-economic impact of this activity, on the one hand on the producers and on the other hand on the fishmongers in charge of selling the fish from the rice-fish farming ponds.

MATERIALS AND METHODS

Study environment

This study was conducted in the Centre-West of Côte d'Ivoire. Five villages located in the Haut-Sassandra region, more precisely in the sub-prefecture of Bédiala, were visited. These were Banoufla, Gnanagonfla, Ourouta, Nanoufla and Zorofla (Figure 1). This part of the region was chosen for the study because it contains the majority of rice-fish farms.

Methodological approach

Two questionnaires (producers and fishmongers) were developed as a data collection tool. The geographical coordinates of the study area (latitude, longitude and altitude) were determined using a GARMIN GPS (Global Positioning System) device, model eTrex 20x.

This survey was made possible by the effective participation of fish farmers who are members of the Bédiala Fish Farmers Association (DEHIZEA). A timetable for the survey was drawn up and contacts were made through intermediaries. The data collection took place over 4 months from April to July 2020 using questionnaires consisting of 27 questions addressed to producers and 26 questions addressed to fishmongers. The study focused on quantitative and qualitative data through the development of open-ended questions under three headings: identification of stakeholders in the rice-fish sector, promoters' opinions on the development of rice-fish farming, and the production and income of rice-fish promoters.

The method of collecting data and other information consisted of direct interviews with DEHIZEA officials. This was done in order to obtain information on the active rice-farmers and especially on the location of their different rice-farming sites. This was followed by a survey of the fishmongers and producers, which took the form of farm visits followed by interviews. The information thus obtained was supplemented by direct observations in the field of the state of maintenance and actions to safeguard the infrastructure and other potential of the facilities. In the course of this study, 202 farms with effective fish farming activity and 30 fishmongers were identified. On the basis of data collected on rice-fish farmers from DEHIZEA officials, 60 or 30% of the rice-fish farms were selected in the areas concerned. The selection was made jointly with DEHIZEA officials using the simple random sampling method. With regard to the efforts related to the maintenance of rice-fish ponds, the distribution of fish feed and fishing, no salary is allocated to these tasks. These tasks are performed by the family. However, the rice bran distributed to the fish is purchased by the promoters.

Data processing

The program XLStat 2016 was used to process the quantitative data. The "EXCEL" software was used to produce the various histograms and the table to better express the results.

As for the information collected from the interviews, the processing was carried out on the basis of the principle of content analysis. The cost of feed used (CFU) and the annual gain of the farm (AGF) were determined with the following mathematical formulas:

CFU (fcfa) = Quantity of feed used (g) × Cost per Kg of feed (fcfa)

AGF (fcfa) = (Annual income from rice + Annual income from fish) − CFU

RESULTS

Socio-economic analyses of the activity of rice-fish producers

Profile of promoters, professional experience and qualifications

Data on the experience of rice-fish farmers show that 86.7% of them have been practising rice-fish farming for more than 5 years and only 13.3% have less than 5 years' experience.

More than half of the rice-fish farmers, i.e., 66.7 %, have not received any training in fish farming, while the remaining 33.4 % have had the opportunity to be supervised by a facilitator from the Association de Pisciculture et Développement Rural en Afrique (APDRA).

In terms of gender, 93.3 % of rice-fish promoters in the study area are men and 6.7 % are women (Figure 2).

The survey revealed that 63.3 % of rice farmers are illiterate, 20 % attended French public schools and 16.7% attended Koranic classes.

With regard to the question of main activity, 63.3% of the respondents are planters, 26.7 % are fish farmers, 6.7 % are traders, 1.7 % are carpenters and 1.7 % are livestock farmers (Figure 3). In addition to these main activities, there are complementary or secondary activities such as yam, maize, groundnut and market gardening.

Fish feeding

The fish species introduced in polyculture in the rice ponds in this locality are Oreochromis niloticus and Heterotis niloticus. Indeed, 50% of the farmers use rice bran as feed, regardless of the stage of development of these fish. Rice bran combined with cassava peelings, other household food and fruits (papaya, avocado, cashew apple) are used by 36.7 % of rice-fish farmers to feed the fish. Only 13.3 % of the rice-fish farmers do not feed the fish. However, the mode of feeding or frequency of feeding the fish is a function of the importance the promoter attaches to the rice-fish farming activity. The performance of rice-fish ponds according to their feeding methods is shown in Figure 4. The average annual fish production in rice-fish ponds increases with the follow-up of the breeding.

Opinion on rice-fish farming and constraints to its practice

Ninety-five percent of the farmers in the study area were introduced to rice-fish farming by friends and family. Although the opinion of all is favourable to rice-fish farming, it is clear that various constraints are encountered during its implementation. The constraints encountered by the rice-fish farmers surveyed differ from one farm to another. Thus, 84 % of the rice-fish farmers deplore a lack of Heterotis niloticus fry and 80 % a lack of funding to obtain agro-food by-products to feed the fish. The accumulation of field work prevents 52% of rice-fish farmers from properly following the fish farming component of this integrated system. Ninety-two percent of the rice-fish farms are located outside the villages, so there is a recurrence of fish theft (32 %). As the ponds are in series, the management of the quantity of water necessary for rice cultivation and fish rearing does not depend on the owner of the farm. For 12 % of the rice- fish farmers, this results in a financial loss (loss of rice and fish) and a rice harvest without a decrease in water level. There is a lack of protective grids in front of the supply pipes of the rice-fish ponds. This leads to an uncontrolled

number of aquatic and terrestrial predators in all rice-fish ponds. The farms that have been purchased (76 %) are sometimes the subject of disputes between the children of the deceased landowners and the rice-fish farmers. These agrarian conflicts were reported on 2 % of the rice-fish farms surveyed (Figure 5).

In economic terms

Annual production of fish and rice

It is important to stress that the farming conditions are artisanal. Oreochromis niloticus and Heterotis niloticus are the species reared. Parachana obscura and Clarias gariepinus are already present in the water used to fill the ponds. For the rice-fish farmers, the objective is to sell the fish and rice. Table 1 illustrates the method of calculating the annual profit of a rice- fish farm after the sale of fish and rice. Fingerlings of O. niloticus and H. niloticus are produced by 86.7% of these actors to stock their different ponds. On the other hand, 13.30% of the producers bought their fingerlings. The annual fish production of 40% of the rice-fish farmers is between 0.5 and 1.5 tonnes. The annual production of 20% is less than 0.5 tons. While 26.7% of rice-fish farmers produce between 1.5 and 2 tonnes, 13.3% produce more than 2 tonnes of fish per year, all species combined. Moreover, the annual rice production of 43 % of rice-fish farmers is between 500 and 1,200 kg. That of 31% is between 500 and 900 kg. While 12 % of rice farmers produce less than 500 kg, 14 % produce more than 1,200 kg of Wita 9 rice annually (Figure 6).

Economic impacts

The rice-fish farmers produce less than 6 tonnes of fish per year. They sell this production between 500 and 1000 CFA francs/kg depending on the size and species, which gives an annual income of less than 5 million CFA francs. The rice-fish farmers are 97% satisfied with the yield of the rice-fish farming system. The price per kilogram of Heterotis niloticus and Clarias gariepinus is fixed at 1,000 CFA francs, regardless of the size of the fish caught. On the other hand, the price per kilogram of Oreochromis niloticus varies between 500 and 1,000 CFA francs. In fact, from 200 g to 500 g the price per kilogram of O. niloticus is 1,000 CFA francs. The price of the same species is set at 850 F CFA with a body weight of between 125 and 165 g. O. niloticus is sold at 500 F CFA per kilogram if it weighs between 100 and 120 g. Most of the fish sold at 500 CFA francs per kilogram is bought by other producers to stock their ponds. Rice and fish are now available in households without having to pay a penny directly. Both rice and fish yields have increased. Pond maintenance costs and overall production costs are low or non-existent. The rice and fish farmers are grouped into cooperatives, which means that the area is visited by various representatives of NGOs, students from public schools and universities, etc. The water from the rice-fish ponds is also used to water the market garden crops located on the edge of the ponds. The average school enrolment rate for children is 75.4 %.

Socio-economic analyses of the fishmongers' activity

At the social level

Socio-professional profile of fishmongers

At the end of the survey, it was found that only women sell fish. As for men, they are content with production only. More than 60 % of female fishmongers are under 40 years of age and 20 % are between 40 and 50 years of age (Figure 7). The sale of fish is the main activity of 80 % of these women, while 20 % focus on agricultural activities such as groundnut, manioc and market gardening.

Regarding the level of education, the results show that 60 % of the women fishmongers are illiterate, 33.3 % have attended a French-speaking public school and 6.7 % have attended Koranic

classes.

With regard to the number of years of experience, 70 % of the fish traders have been trading fish for more than 5 years.

Opinion on rice-fish farming and problems encountered by women fish sellers

Fish produced on site sell very quickly, unlike frozen fish. As in all activities, constraints are encountered by fishmongers in the field. In fact, during the months of August, September, October and November, there is a shortage of fish from the rice-fish ponds. In addition, the high cost of transport to the rice-fish farms should be noted. Transport costs vary between 1,000 and 3,000 CFA francs per person, depending on the distance between the place of residence and the sites. In addition, there is a notable lack of freezers to facilitate the conservation of fish not purchased.

In economic terms

Species and average quantity of fish sold per day per fishmonger

Three different species of fish are sold by the fishmongers. These are Oreochromis niloticus, Heterotis niloticus and Clarias gariepinus. Regarding the best-selling fish species, 60 % of the fishmongers agreed that it was H. niloticus, followed by O. niloticus (Figure 8). Parachanna obscura, although present in the dam ponds, is not one of the products to be sold. The average quantity sold per species and per fishmonger is distributed as follows:

• Oreochromis niloticus: 80 % of fishmongers sell less than 20 kg/d and 20% sell between 20 and 50 kg/d.

• Heterotis niloticus: 60 % of women sell between 20 and 50 kg/d while 40% sell less than 20 kg/d.

• Clarias gariepinus: Less than 20 kg/d of this species is sold by 60% of the fishmongers and the remaining 40% sell a quantity in the range of 20-40 kg/d.

Economic impacts

90% of fish traders are retailers. They buy fish at the farm gate by the kilogram and sell it in retail outlets, taking into account the purchasing power of their target customers. More than 90 % of the fishmongers in the study area sell fish produced on site. In the market, fish from rice-fish ponds do not face major competition. Consumers prefer these fish, unlike frozen fish. Moreover, the activity allows fishmongers to earn an average of 50 to 200 CFA francs per kilogram. The start-up capital is accessible to all. This activity is beneficial for all those who practice it. It provides them with financial autonomy, thus increasing the average schooling rate (72.9 %).

DISCUSSION

Rice-fish farming is practised mostly by men (93.30%) in contrast to fish sales. These results are similar to those of Kimou et al. (2016), i.e. (97.4 %). According to Brummett et al. (2010) and Toily (2009), fish production requires significant physical effort, involves a lot of risk and uncertainty, which means that this activity has remained reserved for men. Moreover, in rural areas the issue of women’s empowerment is thorny. These populations are still in an era where some work is reserved for men and others for women. Hence, trade is reserved for women and rural work for men. It should also be noted that before the advent of rice-fish farming practices in the lowlands, the owners of cultivated plots were men. The women (6.7 %) who are in the rice-fish sector inherited the plots after the death of their spouses. This finding is the same as that made by Tomedi et al. (2009). According to these authors, the dominance of men is linked to the fact that women are not

landowners.

Fish farming is a secondary activity for the producers surveyed, who come from different social strata, but are predominantly farmers (63.3 %). This result corroborates with that of Atsé et al. (2017). These authors state that farming is the main activity of most fish farmers (62 %) in the South-East and Centre-West regions. These farmers are increasingly turning to rice-fish farming as their main activity. This orientation towards the rice-fish sector would seem to be linked to the instability of selling prices for industrial and food products (Efolé et al., 2012). These observations are different from those made in Burkina (MIPARH, 2009), where owners put fish farming activities first.

The rate of fish farming training (33 %) in this study is higher than that obtained by Atsé et al. (2017) in the Centre-Ouest region (19%). Producers gain experience after confronting the realities of the field and resource persons. Unlike in Côte d'Ivoire, in Benin the population's investment in fish farming activities is made following demonstrations and awareness-raising by public services (MIPARH, 2009). For the production of market-sized fish (200 g), rice-fish farmers feed the fish with rice bran (86.7 %). Since this feed is not subject to quality control, MIPARH (2009) states that there is no information on the effectiveness of its quality. The method of feeding and the high use of agri-food by-products as fish feed observed in this study would be linked to the main activity of the promoters on the one hand, and to the inability of rice-fish farmers to use commercial feed on the other (Brechbühl, 2009; FAO, 2008). The use of rice bran could be justified not only by its low cost but also by its availability (Atsé et al., 2017). Rice and maize are the two main cereal crops in the area. These results are in agreement with those of Kimou et al. (2016). According to these authors, the frequency of use of agro-food by-products is 40.7 % in rural areas and 75 % in the Haut Sassandra region. The acquisition of commercial food is difficult for these populations. Indeed, a bag (100 kg) of rice bran, which used to cost 100 CFA francs, has gradually risen to 200 CFA francs, 500 CFA francs and now 1,000 CFA francs.

As for the bag (100 kg) of maize bran, it has risen from 1,000 CFA francs to 3,000 CFA francs to date, depending on whether there is an abundance or a shortage, probably due to demand. This observation was also made by Atsé et al. (2017) in the Centre- Ouest region. These prices although derisory to others are considered a fortune to most rice- fish farmers. However, the feeding technique or frequency of fish feeding observed in this study is that of extensive fish farming. This form of artisanal fish farming uses a feed based on agri-food by-products and sexing of fry combined with organic fertilisation (MINIGRA, 2000). This typology of production systems contrasts with that described by MIPARH (2003), which states that fish farming in Côte d'Ivoire is practised under intensive and semi-intensive modes.

The annual fish production obtained in this work is lower than the range defined by Toily (2009) for semi-intensive farming but identical to that of extensive farming. According to this author, the yield of this system is 6 to 8 tonnes/ha/year compared to 1 to 1.5 tonnes/ha/year. This production is within the range defined by Zhang (1995) and Hem et al. (2001). According to these authors, the production per crop can vary from 100 to 750 kg/ha/year without feeding, while with feeding the result could be between 1055 and 1812 kg/ha/year. The low yields obtained would be due to the nutritional quality of the agri-food by-products used for feeding on the one hand and the daily feed ration of the fish on the other. The low protein content and low fibre digestibility of the agricultural by-products by the fish can lead to these low yields (Burel and Médale, 2014; Kimou et al., 2016). The amount of fish that can be harvested from rice-fish farms could also be related to the stocking density and the size of the fish at the time of stocking.

In this production, Heterotis niloticus is the species most and best sold by fishmongers. This would seem to be related to its large size, its fairly tender flesh and its flavour when cooked which is appreciated by all. In contrast to the above, Clarias gariepinus is a species that is appreciated differently by the population. While others have no problem with its consumption, some make it a sacred species and therefore a totem. This has a negative impact on its consumption.

In the area visited to conduct our survey, there is an organisation of fish farmers (DEHIZEA). However, this result differs from those obtained by Bamba (2002). The analysis made by this author shows an absence of organisation within the fish farming sector in Côte d'Ivoire. Rice- fish farming has flooded the study area through friends and family. This integrated management system is beneficial for both fish and rice plants. The fish droppings serve as fertiliser for the rice plants, and the rice plants provide shade and oxygen through photosynthesis. Fish stocking and grow-out in rice fields is basically an extensive aquaculture system that relies mainly on wild food in the rice fields (Halwart and Gupta, 2010). In addition, rice-fish farmers no longer plough the rice plots and water is permanently available for rice cultivation and fish farming. In addition, after the rice harvest, the straw is piled up in the pond to serve as an indirect feed (fertiliser) for the fish. The sale of fish and rice justifies the lucrative nature of this activity. Rice-fish farming provides farmers and local populations with inexpensive animal protein and a significant additional income (Atsé et al., 2017). From an environmental point of view, the elimination of Anopheles larvae and molluscs by fish can be considered as a good method to fight malaria and bilharzia (Lacroix, 2004).

Despite the many advantages of rice-fish culture, obstacles are often encountered in practice. The lack of water management in the feeding canal often harms the rice and the fish. For example, a rice-fish pond that is closed too early can cause flooding of young rice plants. If it is closed too late, the amount of water collected will affect the growth of the fish. It is necessary to have a perfect knowledge of the climate before committing oneself. To avoid this disastrous situation, some farmers harvest rice in open water, even though it is exhausting. The constraints due to the accumulation of field work are explained by the fact that the producers are not able to follow the fish farming properly due to lack of time and personnel. The lack of Heterotis niloticus fry could be linked to the fact that artificial reproduction of this species is currently difficult. Bad neighbourliness and land conflicts are detrimental during development work. This problem may be the cause of flooding of rice plants. For example, if the bypass channel has to pass over land that does not belong to the developer and the developer's neighbour is not understanding enough, he will not be able to implement the system at all. The undefined number of predators (Clarias gariepinus and Parachana obscura) in the ponds is explained by the fact that the feeder channels are uncontrolled (no protective grids at the entrance and exit) while the ponds are in series. However, these women are not unfamiliar with fish conservation methods, but the majority of them cannot afford a freezer as a conservation tool.

The practice of rice-fish farming in Haut Sassandra can be easily carried out at the social level because the lowlands are available and the owners of these lands are welcoming. Economically, the cost of developing the lowlands up to the point of stocking is high. In addition, there is a lack of money to buy fry to stock the ponds. The overall cost of production is reduced because the use of herbicides and fertilisers by rice-fish farmers is low or non-existent. This integrated system has become the main source of income for the promoters. It has significantly improved their living conditions through the realisation of major works and is therefore an invaluable financial support for these rural producers. The annual income of the farms is less than 5 million CFA francs. This result falls within the range (412,666 to 4,329,255 CFA francs) defined by Kimou et al. (2016). This average annual production income seems to have satisfied fish farmers for many years (Kimou et al., 2016). This production capacity could be improved by making quality feed available at lower cost, formulated from accessible local raw materials (Hecht, 2007). Indeed, the cash crops that used to be the source of income for these farmers are currently experiencing a decline in price. These results are in line with the assertion of Kaudjis (2005). According to this author, the crisis following the fall in the prices of the main agricultural commodities on the international markets, the increase in poverty and food insecurity having upset the habit of farmers, many countries in sub-Saharan Africa consider aquaculture as an alternative for food and economic independence. It is the farmer himself who sets the selling price of the fruits of his labour. He can then set his own schedule and does not have to wait for a specific period to sell his products. The fish produced on site would taste good compared to frozen fish, which is why they are sold more quickly than the latter. The option of fish sellers to sell fish produced on the spot instead of frozen fish is linked to the means of preservation (freezers or cold rooms) and large business assets. Whereas the capital

to start the trade of locally produced fish is accessible to all. The producers agree to give the fish to the women to sell and come back to honour their commitments. Since the business value of this activity is very low or even insignificant, everyone can be interested in it while waiting for large-scale funding to improve their working conditions and income.

CONCLUSION

At the end of this study, it was found that rice-fish farming is effective in the Haut Sassandra region, even if it remains a secondary activity for many promoters. The frequency of production remains low due to the lack of working capital for the purchase of fry and food inputs (agro-food by-products). This low level of production is a major obstacle for the adequate distribution of fish, which is done through a short circuit. In sum, the socio-economic results obtained in this work show that rice-fish farming has a positive impact on all the actors in the sector. It has led to a clear improvement in the living conditions of the rural population. Although the opinion of all parties is favourable to the practice of rice-fish farming, it must be noted that the actors in the sector encounter various constraints. For a better expansion of this activity in Côte d'Ivoire, the implementation of an action plan with the participation of all actors under the supervision of the Ivorian state would allow the development of efforts to increase productivity.

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