BirEx JOURNAL
Budapest International Research in Exact Sciences
Medical, Biological, Argiculture, Engineering
Science and other related areas
e-ISSN : 2655-7827
p-ISSN : 2655-7835
http://www.bircu-journal.com/index.php/birex

Practices of fish farmers: techniques, characteristics, feeding, and type of aquaculture farming in the district of Antsirabe I Vakinankaratra Madagascar

Rabarison Rindra[1], Ramanambe Ravelomanantsoa Nicole[1], Rabeharitsara Andry Tahina[1], Koto-te-Nyiwa Ngbolua[2,3]

[1]*Engineering and Industrial Process, Agricultural and Food Systems, Polytechnic High School of Antananarivo, Madagascar*

[2]*Department of Biology, Faculty of Science and Technology, University of Kinshasa, Kinshasa,Democratic Republic of the Congo*

[3]*National Scientific Council, Ministry of Scientific Research and Technological Innovation, Democratic Republic of the Congo*

Abstract: *This study aims to explore the current practices of fish farmers, focusing on the different rearing techniques and the use of aquaculture environments in Antsirabe Vakinankaratra. In particular, the survey examines the management of rearing environments, the selection of species for rearing types, feeding and the characteristics of rearing environments. Many fish farmers notice significant benefits from their farming method. However, several problems persist, this situation, calls for training initiatives and financial support to optimize their production and ensure the sustainability of their activities.*

Keywords: *Aquaculture, tilapia, carp, rearing techniques.*

I. Introduction

Aquaculture, particularly fish farming, is a rapidly growing activity in Madagascar, playing a crucial role in food security, poverty reduction, and job creation in rural areas (Andrianaivoarisoa & Rabetaliana, 2020). The main species farmed include tilapia (Oreochromis niloticus) and carp (Cyprinus carpio), which are well-suited to the country's climatic and hydrological conditions (Andriatsarafara et al., 2019). These fish are highly valued for their ease of farming, disease resistance, and rapid growth, making aquaculture an attractive option for small-scale farmers (FAO, 2021). Several farming practices have been adopted to enhance productivity while minimizing environmental impacts. Among these, polyculture and the integration of fish farming with agricultural systems are widely employed by farmers (Rakotomanana, 2018). These techniques not only improve pond productivity but also diversify income sources for rural communities (IFAD, 2022). However, Madagascar's aquaculture sector faces significant challenges, including limited access to quality inputs such as fry and fish feed, inadequate farmer training, and land tenure insecurity (Ralambomanana, 2017). To address these challenges, various support projects have been launched by the government and international organizations. These initiatives aim to strengthen farmers' technical capacities and promote sustainable management of aquatic resources (UNDP, 2020). Improving aquaculture infrastructure, providing continuous farmer training, and facilitating access to financing for modernizing facilities are central to these efforts (World Bank, 2019). Additionally, sustainable management of ponds and aquatic ecosystems is essential for ensuring the long-term viability of aquaculture in Madagascar (Rakotonirina et al., 2016).

DOI: *https://doi.org/10.33258/birex.v6i4.8008*

Despite these challenges, aquaculture has the potential to play a key role in reducing dependence on fish imports and improving food security on the island (Razafindralambo, 2021). With sustainable practices and proper resource management, fish farming can contribute to economic growth while preserving aquatic environments (Andrianaivoarisoa & Rabetaliana, 2020). The study on fish farming practices in Antsirabe aims to analyze local environmental conditions, production methods, and feeding practices to optimize fish growth. It also seeks to evaluate the impact of aquaculture methods on the local ecosystem. Finally, the objective is to understand practices that promote sustainable aquaculture activities, enabling the development of practical skills to improve productivity while respecting the environment.

II. Research Methods

The survey was conducted among 75 fish farmers in Antsirabe I district, with a focus on tilapia and carp farms, two widely used aquatic species. Information was collected by means of questionnaires and interviews in the field, covering everything from the profile of the farmers to the feeding of the fish. The data was then analysed to understand practices and results.

III. Results and Discussion

Table 1. Characteristics of farmers

	Nomber	**Percentage**
Gender		
Male	57	76,00
Female	18	24,00
Total	75	100
Age		
25-35	4	5,3
35-45	6	8,0
45-55	41	54,7
More than 55	24	32
Total	75	100
Level of education		
No	5	6,7
Primary	20	26,7
Secondary	41	54,7
University	9	12,0
Total	75	100
Place of residence		
Antsirabe North	13	17,3
Antsirabe Center	12	16,0
Antsirabe East	14	18,7
Antsirabe West	20	26,7
Antsirabe South	16	21,3
Total	75	100

The number of farmers surveyed was 75, including 57 men and 18 women. More than half of the respondents were between 45 and 55 years of age, and 32% were over 55, which means that the farmers are of mature age. More than half (54.7%) have more than secondary education, and some have reached terminal level. Primary education accounts for 26.7% and university education for 12.0%. Their place of residence is in the District of Antsirabe II and some in Antsirabe I.

Table 2. Secondary activity other than fish farming

Activities	**Number**	**Percentage**
Farmer	31	41,3
Employee	8	10,7
Breeder	9	12,0
Fish farmer	6	8,0
Others	21	28,0
Total	75	100

53% have their secondary activity in agriculture and livestock farming. This means that the combination of the two activities is favourable. Activities other than rural activities are employees. The others practice activities such as: security guard, merchant....

Table 3. Number of years in practice

Years	**Number**	**Percentage**
1-5	9	12,0
5-10	20	26,7
10 and more	46	61,3
Total	75	100

61.3 % have been in the fish farming business for more than 10 years. Those less than 10 years old started up after training or to invest.

Table 4. Origin of experience acquired

Origin of experience acquired	**Number**	**Percentage**
Traditional	45	60,0
Training	30	40,0
Total	75	100

60% of the surveys have inherited the know-how of their elders. They have no training or capacity building in fish farming. The other 40% have received training from various public bodies such as the Regional Fisheries Directorate and private organisations.

Table 5. Training duration

Duration	**Number**	**Percentage**
Short	20	66,7
Long	10	33,3
	30	100

1/3 have undergone long-term training. The duration varied from one week to several months. The locations are in the Vakinankaratra Region and in Antananarivo.
Generally speaking, the training concerns:

1. Choice of species: Select the appropriate fish species for your breeding project according to their adaptability to your region, their market demand and your specific objectives.
2. Setting up a rearing system: Prepare the facilities needed to house the fish, whether they be tanks, floating cages or other types of structure. Make sure that the environment provides adequate conditions in terms of water quality, temperature, oxygenation and protection from predators.
3. Stock acquisition: Obtain the fish to be reared from reliable sources, such as specialist hatcheries or reputable suppliers. Maintain good fish health and prevent disease by quarantining and monitoring your stock regularly.
4. Feed: Provide an appropriate and balanced diet for fish to promote growth and health. This may include commercial feeds specially formulated for fish, as well as natural or artificial supplements if necessary.
5. Environmental management: Monitor and maintain water parameters such as temperature, pH, salinity and overall quality to create optimum conditions for the fish. Also ensure adequate filtration and aeration of the water.
6. Growth and health monitoring: Regularly monitor the growth, behaviour and health of the fish. Identify and treat diseases or health problems quickly to minimise losses and maximise yield.
7. Marketing: Plan the marketing of your fish according to market demand. Identify the appropriate distribution channels, such as local markets, restaurants, fishmongers or online sales.

Table 6. Fish breeders' associations

Involvement in cooperatives or associations			
	Number	**Percentage**	
Yes	22	29,3	
No	53	70,7	
Total	75	100	
Year in the cooperative or association			
Year	**Number**	**Percentage**	
Less than 3	1	4,5	
3	2	9,1	Average 8,50 Min 2 Max and more de 10
4	0	0,0	
5	1	4,5	
6	1	4,5	
7 and more	17	77,3	
Total	22	100	

Fish farmers' co-operatives are organisations or associations formed by fish farmers who come together to work together, share resources and knowledge, and promote their common interests in the fish farming industry. Co-operatives offer many benefits to fish farmers. These include :

- Sharing costs and resources: Co-operatives allow fish farmers to share the costs of equipment, infrastructure, research and development, marketing and other expenses. This can reduce individual costs and enable farmers to benefit from economies of scale. In addition, co-operatives facilitate the sharing of knowledge and technical resources between members, helping to improve husbandry practices.
- Access to larger markets: Co-operatives can help fish farmers to access larger and more diversified markets. By grouping together, they can increase their production capacity, meet specific buyer demands and benefit from greater market visibility. Cooperatives can also

facilitate certification and compliance with quality and sustainability standards, which can open up additional business opportunities.
- Collective voice and advocacy: Co-operatives enable fish farmers to speak with one voice and advocate for their common interests. They can represent farmers in discussions with authorities, government institutions, research organisations and other industry stakeholders. This can help to influence policy, promote the sustainable development of fish farming and solve the problems and challenges facing the industry.

Only 22 farmers have been involved in farmers' organisations, 17 of whom have been involved for more than 7 years.

Table 7. Profit-sharing in the field

Area of profit-sharing	**Number**	**Percentage**
Investment	1	1,3
Self-sufficiency	4	5,3
Entertainment	7	9,3
Mixed (investment, self-sufficiency, entertainment)	63	84,0
Total	75	100

Most of them are looking for investment, self-sufficiency and entertainment (84%). The fish farming sector is a great opportunity for investment, as well as producing its own source of protein. The scarcity of marine resources explains the increase in production. Farming for entertainment for farmers with small areas and nurseries.

Table 8. Workforce characteristics

Nomber of workforce characteristics		
Number of employees		**Percentage**
0	2	2,7
1	21	28,0
2	20	26,7
3	19	25,3
4	8	10,7
5	4	5,3
6	1	1,3
Total	75	100
Number of skilled workers		
0	44	61,1
1	20	27,8
2	8	11,1
Total	72	100
Labour time		
Permanent	38	52,1
Seasonal	35	47,9
Total	73	100

Generally speaking, labour is often neglected, as the activities are carried out by the farmer himself. However, some farmers (38.9%) used skilled labour.

Fish farming can be labour-intensive, particularly for tasks such as facility maintenance, fish monitoring, feeding, water quality control, stock management, harvesting

and product marketing. Requirements vary according to the size of the farm and the type of farming system used.

About workforce skills and qualifications: Employees working in fish farming need specific skills and knowledge. This may include an understanding of fish rearing practices, fish handling and care techniques, as well as water management and facility maintenance skills. Skilled labour is varied and in most cases is a qualified person.

52.1% of farmers use permanent labour. Seasonal work (47.9): fish farming can be seasonal, with periods of increased activity during certain seasons of the year, such as the fish-growing season. This may require a seasonal workforce to cope with fluctuating demand.

Working conditions in fish farming can vary depending on the type of farming system and the tasks performed. This can include working outdoors, in direct contact with the water, as well as physical tasks such as handling fish, cleaning facilities and harvesting. It is important to put in place appropriate safety measures and to

Table 9. Type of farming environment

Farming environments	**Number**	**Percentage**
Pond	37	49,3
Basin	4	5,3
Cage	0	0,0
Rice-fish farming	27	36,0
Mixed	7	9,3
Total	75	100

Each system has its own advantages and is suitable for specific fish species. The majority of farmers use ponds as a breeding environment (49.3%), followed by rice paddies. The town and surrounding area of Antsirabe have many sources of water for ponds, and most of the villages on the outskirts of Antsirabe town grow rainfed rice.

The basin or reservoir is 5.3%. Fish farmers choose to rear their fish in ponds in order to better control the water and feed parameters, thus promoting faster growth and better productivity. Few farmers use ponds.

None of the farmers use cages, and the fishermen's associations FIFIMPAVA (Fiombonan'ny Fikambanan'ny Mpanjono eto Vakinankaratra) are considering cage farming in the lakes at Andraikiba, Andranobe and Tatamarina.

Table 10. Workforce by area and type of environment

Environments	**Surface**	**Number**
Pond	Less than 50 m^2	1 :3 2 :3
	50-250 m^2	1 :16 2 :3 3 :3 4 :2
	250-500 m^2	2 :2 3 :6

Basin	Less than 50 m^2 150-250 m^2 250-500	0 :1 2 :2 2 :1 3 :1
Rice field	100-250 m^2 250-500 m^2 More than 500 m^2	2 :2 1 :2 2 :1 3 :8 4 :4 1 :1 2 :3 3 :4 4 :4 5 :4 **6 :1**

Table 11. Type of production

Type	**Pond**	
	Number	Percentage
Subsistence fish farming	6	13,6
Small-scale commercial	31	70,5
Large-scale commercial	7	15,9
	44	100
Type	**Rice-fish farming**	
	Nomber	Percentage
Traditional	11	39,3
Semi-intensive	17	60,7
	28	100
Type	**Basin**	
	Nomber	Percentage
Intensive	0	0
Semi-intensive	3	66,7
Leisure	1	33,3
Total	4	100

For the production of ponds, 70.5% are small-scale productions with total pond areas between 100 to 250m2 and which produce approximately 75 to 250 kg per harvest and 15.9% for large scale. 13.6% are subsistence fish farms whose products are consumed only by the fish farmer.

Intensive rice-fish farming represents 60.7% and 39.3% for traditional. Breeders who practice traditional rice-fish farming are gradually turning to semi-intensive production thanks to awareness-raising from NGOs or organizations in the fish farming sector.

Semi-intensive pond production is 66.7% which is just intended for sale and 33.3% for personal leisure.

Table 12. Operating surface area

Type	Surface	Number	Percentage
Pond	Less than 50 m^2	6	13,6
	50-250 m^2	31	70,5
	250-500 m^2	7	15,9
	More than 500 m^2	0	0
Basin	Less than 50 m^2	1	25
	50-250 m^2	0	0
	250-500 m^2	1	25
	More than 500 m^2	2	50
Rice field	50 à 100 m^2	0	0
	100 à 250 m^2	2	5,9
	250 à 500 m^2	15	44,1
	More than 500 m^2	17	50

The surface needed for fish farming depends on several factors, such as the type of culture system used, the number of fish raised and production goals.

Ponds are the most used. The area required varies depending on the number of fish and desired densities. Small ponds can be a few hundred square meters, 70.5 % of breeders have an area of 50 to 250 m2, while large commercial ponds can reach half a hectare.

The rice fields are after the pond the most used 50 % have an area more than 500 m2, 44.1% have an area between 250 to 500 m2 and 5.9% an area between 100 to 250 m2.

Table 13. Number of land according to breeding environments

Environments	Number	Percentage
Pond	1	63,6
	2	20,5
	3	9,1
	4	6,8
Basin	1	25,0
	3	25,0
	4	25,0
	8	25,0
Rice field	1	20,6
	2	4102
	3	26,5
	4	11,8

The majority of operators of several breeding environments, whether for ponds or rice fields. The basins vary according to the operating modes, the maximum number of basins is 8.

Its sites are generally located in homes or around 100 to 200m away.

Table 14. Bred Species

Species	Number	Percentage
Tilapia	6	8,0
Carp	22	29,3
Mixed	47	62,7
Total	75	100

Density / m^2		
Pond	Unknown: 8 1-2: 13 2- 3: 12 3-4 :12 Breeders depending on the size of the land: 6	10,7 28,9 26,6 26,6 7,2
Basin	Unknown: 1 4-6 : 1 10-20 : 1 30 : 1	25,0 25,0 25,0 25,0
Rice-fish farming	1-2 : 21 2-3 : 12 3-4 : 1	33,33 33,33 33,33
Stocking		
0 1 2	17 48 10	22,7 64 13,7
Harvest		
1 2 3 4 5	39 22 7 4 3	52 29,3 9,3 5,3 4

Breeders raise both tilapia and carp 62.7% they are found almost in all Vakinankarartra. 29.3% only raise carp, they are located in Betafo and Manandona thanks to the ideal breeding conditions for carp.

The density of fish varies depending on the financial means of the breeder for breeding in ponds and rice fields, the density is between 1 to 4 fish per m2. The pool from 4 to 30 per m2. The unknown densities are the breeders who let the fish breed in the pond and only harvest 3 to 4 times a year and do not do poisoning and emptying.

For stocking, 64% carry out only one during the stocking season (October to November); rearing in rice fields is the most numerous. For ponds and ponds, operators poison at most twice a year. Some pond breeders do not poison the fish that reproduce in the environment and do not require purchasing fry.

The harvest time differs depending on the environment, in ponds, breeders harvest several times a year between 2 and 5, for rice-fish farming once before the rice harvest and in ponds 1 to several times depending on the number of stockings.

Table 15. Source of fish

Source or origin	**Number**	**Percentage**
Purchase	60	80
Don	1	1,3
Natural catchment	0	0
Reproduction of fish in the environment	14	18,7
Total	75	100

80% of breeders buy the fry from the fry producer around Antsirabe. The fish purchased is generally purchased from Betafo and Manandona, the largest fry producers in the Vakinankaratra region.

Table 16. Fish reproduction

Reproductive mode	**Number**	**Percentage**
Natural	75	100
Artificial	0	0
Total	75	100

Some farmed fish are intended for breeding and the replenishment of farmed fish populations. This can be done with the aim of restoring fish stocks in natural water bodies, ponds, or cages, supporting commercial or food fishing, or preserving endangered species. Breeding is natural for all farmers.

Table 17. Growth characteristics

Period	**By producer**	**Percentage**
Winter season	Slow : 75	100
Summer	Fast : 75	100

Table 18. Duration of farming according to producers

Duration (month)	**Number**	**Percentage**
Less than 4	1	1,3
4 à 8	58	77,5
8 à 12	3	4,0
12 à 16	8	10,7
16 à 20	0	0
More than 20	5	6,7
Total	75	100

The duration of fish farming can vary considerably depending on several factors, such as the species of fish, farming conditions, production goals, and management practices. It is important to note that the farming duration can also be influenced by factors such as environmental conditions, feeding, genetics, water quality, and the management practices adopted by the farmer. It is essential to consider these factors to determine the specific farming duration for fish in a given context. Some commonly farmed fish species, such as carp or tilapia, can be farmed over a period of a few months to a year, depending on the desired final size. For example, farming carp can take 6 to 12 months, depending on farming conditions and commercialisation goals. 77.5% of farmers raise their fish for 4 to 8 months.

Table 19. Characteristics of farming at the start of breeding

Minimum weight			
Tilapia	5-15gr	50 5	90,9 9,1
Carpe	5 -15gr	62 7	89,9 10,1
Miximum weight			
	Weighy	**Number**	**Percentage**
Tilapia	Fry (1 à 30gr) 30-50gr 50 -100gr	45 9 1	81,9 16,4 1,7
Carp	Fry (1 à 30gr) 30-50gr	46 23	81,1 18,8

	More than 50gr	0	0

The weight of fish can vary depending on the operator and the species of fish. The minimum weight at the start of rearing for tilapia and carp is from the fry stage, approximately 1 to 30 grams. The maximum weight at the start of rearing is 30 to 50 grams for tilapia and carp.

Table 20. Characteristics of farming at the end of rearing

	Miximum weight		
	Weight	**Number**	**Percentage**
Tilapia	100-250 gr	3	5,5
	250-500 gr	52	84,5
Carpe	25 -50 gr	3	4,4
	150-250 gr	1	1,5
	250-500 gr	7	10,3
	500-1000 gr	21	30,9
	1-1,5 kg	28	41,2
	1,5-2 kg	7	10,3
	More than 2kg	1	1,5
	Minimum weight		
Tilapia	75-150 gr	41	74,6
	150-250 gr	14	25,4
	250-500 gr	0	0
Carpe	5 -25	3	4,4
	100-250 gr	22	32,4
	250-500 gr	40	58,8
	500-1000 gr	2	2,9
	1000-2000 gr	1	1,5

(85.4%) of the maximum weight at the end of the farming period is between 250 and 500 grams for tilapia, while 5.5% fall between 100 and 250 grams. For the minimum weight, 74.6% of the farmers report weights between 75 and 150 grams, and 25.4% report weights between 150 and 250 grams at the end of the farming period.

For carp, the fry are sold at weights between 25 and 25 grams, which is the maximum weight, and between 5 and 25 grams is the minimum sold to other fish farmers. At the end of the farming period, different maximum weights are observed for carp: 11.8% have a maximum weight ranging from 150 to 500 grams, 30.9% from 500 grams to 1 kilogram, 51.5% from 1 kilogram to 2 kilograms, and 1.5% for weights exceeding 2 kilograms.

In terms of minimum weight, the small carp intended for sale weigh between 5 and 25 grams, 32.4% weigh between 100 and 250 grams, 58.8% weigh between 250 and 500 grams, and 4.4% of carp weigh between 500 grams and 2 kilograms at the end of the farming period.

Table 21. Type of feeding

Given feed		
Origin	**Number**	**Percentage**
Homemade	48	57,3
Purchased	21	28
Mixed	7	14,7

Totale	75	100

Homemade feeds account for 57.3% of these feeds, which are generally food scraps or agricultural by-products such as rice bran, cake meal, and cassava flour, produced or purchased by the farmer and made by themselves. Purchased feeds are produced by large animal feed manufacturers such as LFL Madagascar, AGRIVAL, and ARBIOCHEM. Rice bran, maize flour, and peanut cake meal are the most commonly used by farmers who make their own feeds.

Table 22. Feeding form

Feed composition	**Number**	**Percentage**
Flour	21	28
Crumbs	17	22,7
Granulated	2	2,7
Otherss	9	12
Mixed	26	34,7
Total	75	100

Farmed fish are typically fed with commercially formulated feeds specifically designed to meet their nutritional needs. These feeds are available in the form of pellets, flakes, or powders and are designed to provide a balanced diet containing essential proteins, lipids, carbohydrates, vitamins, and minerals.

Composition of feeds: The composition of the feeds varies depending on the fish species, its stage of development, and production goals. Feed for farmed fish is generally protein-based, which may come from sources such as fish, fish by-products, animal meals, plant proteins, or synthetic proteins. Lipids (fats) are also included to provide energy, along with vitamins and minerals to ensure healthy growth and development.

Table 23. Manufacturing method of the feed

Method	**Manufacturing**	**Percentage**
Handmade (Manual)	55	73,3
Machine	2	2,7

73.3% manually produce their own feed, using a manual meat grinder to obtain pellets or simply mixing the ingredients for the flours. The machines used by the 2.7% are electric pellet machines that produce pellets.

Table 24. Knowledge of dietary needs

Knowledge	**Number**	**Percentage**
Yes	29	38,7
No	46	61,3
	75	100
Rationing		
- For rice-fish farming and pond culture, the feeding is done 1 to 3 times a day for semi-intensive rice-fish farming and 1 to 3 times a week for traditional methods. The basins are fed 3 to 4 times a day depending on the weight of the fish.		

Table 25. Quantity of feed (kg/an)

Quantity (en kg)	**Numbre**	**Pourcentage**
unknown	17	22,7
5 -10	11	14,7
10-50	35	46,7
50-100	7	9,3
More than 100	3	4

The amount of feed used varies depending on the type of production and the type of farming. Semi-intensive farming in ponds consumes between 50 and over 100 kg of feed per year, while pond and semi-intensive rice-fish farming use between 10 and 50 kg. Unknown quantities of 5-10 grams are generally found in traditional productions.

Table 26. Harvesting method

Harvesting method		
Pond	Basin	Rice field
Grape harvest	Grape harvest	During the rice harvest

Table 27. Harvest parameter

Indicator	**Number**	**Percentage**
Age	52	69,3
Weight	12	16,0
Mixed	11	14,7
Total	75	100

The harvesting parameters vary depending on the farmer and the type of farming environment. For rice-fish farmers, harvesting takes place before the rice harvest, with the age of the fish ranging from 4 to 7 months. For ponds and lakes, harvesting is determined by both the age and weight of the fish.

Table 28. Monitoring of breeding

Monitoring carried out	**Number**	**Percentage**
Yes	70	93,3
No	5	6,7
Total	75	100

Monitoring fish farming is crucial to ensure the optimal health and growth of the fish, as well as to guarantee effective management of the operation.
Growth and Development: Monitoring the growth and development of fish is essential for assessing their health and performance. This can be achieved by regularly measuring the length and weight of the fish, noting growth rates, monitoring the condition factor, and comparing the data to species standards. Tracking growth helps identify any potential health or nutritional issues.

Mortality: Monitoring mortality is important for evaluating fish survival rates and identifying potential causes of death. Recording the number of dead fish, determining possible reasons for mortality (such as diseases, environmental conditions, management issues), and taking appropriate corrective measures are crucial.

Regular monitoring of these parameters enables operators to quickly detect potential problems, adjust management practices, optimise production performance, and improve the overall health of the fish.

Table 29. Production

The objective of farming		
Fattening	67	89,3
Production of fry	4	5,3
MixED	4	5,3
Profitability		
Yes	73	97,3
No	2	2,7
Destination of fish		
Household consumption	11	14,7
Commerce	2	2,7
Mixed	62	82,7
	Form of sale	
Fresh	59	78,7
Autres	5	6,7

Farmed fish can have different destinations depending on the objectives of the operation and market demands.

The primary destination for farmed fish is the food market. Farmed fish can be sold as fresh, frozen, or dried products. They can be distributed to restaurants, fishmongers, supermarkets, local markets, or exported to other regions or countries.

Reproduction and restocking: Some farmed fish are intended for breeding and restocking wild fish populations. This can be done with the aim of restoring fish stocks in natural water bodies, supporting sport fishing, or preserving endangered species.

Table 30. Diagnostic

Successful breeding		
Yes	Yes : 46	61,3
No	No : 29	38,7
Issues during farming	Yes :71 No : 4	94,7 5,3
Feeding problems	Yes:59 No : 16	78,7 21,3

By conducting a diagnostic of fish farming activities, it is observed that 61.3% assert that the activity is beneficial.

The main problems during farming are insecurity, theft, and the reduction of water for ponds and rice fields. There is also foza orana (Procambarus). 94.7% of farmers experience issues during farming. These problems concern:

- Lack of knowledge in fish farming (environment, dietary needs, feed production).
- Impact on ecosystems: The escape of farmed fish can have an impact on wild fish populations, particularly if the farmed fish carry diseases or breed with wild species.
- In terms of feeding, 78.7% report experiencing problems. The issues include the cost of feed ingredients, and fingerlings are too expensive. The outdated infrastructure is also a problem.

- Dietary needs: Feeding farmed fish can pose challenges in terms of cost and availability of feed. The ingredients used in fish feed may come from limited sources, which can lead to sustainability issues and dependence on certain resources.

Table 31. Project cost

Amount (Ariary)	**Number**	**Percentage**	
Less than 500,000 Ar 500,000-999,999 Ar More than 2,500,000 Ar	65 9 1	86,7 12 1,3	Average =188,660 Median = 70000 Min= 10000 Ar Max = 3000000 Ar
Expansion of the project			
Yes No	73 2		97,3 2,7

Discussion

Fish farming, particularly aquaculture, has grown substantially in Madagascar, offering significant contributions to food security, poverty reduction, and rural employment. The district of Antsirabe, in the Vakinankaratra region, has become a focal point for fish farming, with local farmers employing various techniques to raise species like tilapia (Oreochromis niloticus) and carp (Cyprinus carpio). This discussion delves into the various practices, challenges, and opportunities in the region's aquaculture sector.

Fish farming is vital in Madagascar, particularly due to the country's reliance on aquatic resources for both nutrition and income generation (FAO, 2021). Species like tilapia and carp are favored for their adaptability and rapid growth, making them ideal for small-scale farmers (Andrianaivoarisoa & Rabetaliana, 2020). Farmers in Antsirabe often integrate fish farming with agricultural activities, enhancing pond productivity while diversifying income streams (Rakotomanana, 2018).

Farmers in Antsirabe employ a range of rearing systems, from traditional pond farming to rice-fish farming. The majority, 49.3%, use ponds as their primary rearing environment, which allows better control of water and feeding parameters, thereby promoting faster growth and higher productivity (World Bank, 2019). The practice of polyculture, raising multiple species in the same environment, is common, with 62.7% of farmers raising both tilapia and carp. This technique enhances biodiversity and optimizes resource use (Rakotonirina et al., 2016).

The socio-economic benefits of fish farming are evident, as 84% of farmers view aquaculture as both a self-sustaining and profitable investment. However, challenges remain, such as limited access to quality inputs like fry and fish feed, which hampers productivity (Ralambomanana, 2017). Additionally, the cost of feed remains a significant hurdle, with 78.7% of farmers reporting difficulties in feeding their fish due to high prices (UNDP, 2020).

Fish farming also has a direct impact on local employment, with 52.1% of farmers employing permanent labor (Razafindralambo, 2021). Skilled labor, however, remains scarce, with 61.1% of the workforce lacking formal training in aquaculture.

Feeding practices in Antsirabe vary, with 57.3% of farmers making their own feed using agricultural by-products like rice bran and cassava flour. However, the quality and availability of commercial feeds, which are produced by companies like LFL Madagascar and AGRIVAL, pose challenges. Farmers who can afford commercial feeds report better growth rates and overall productivity (FAO, 2021). The feeding methods and composition used by farmers directly influence the growth and health of their fish stocks (Rakotonirina et al., 2016).

Sustainability is a crucial concern in fish farming, particularly regarding water quality and environmental impacts. In Antsirabe, farmers monitor water parameters such as temperature, pH, and salinity to create optimal conditions for fish growth (Ralambomanana, 2017). However, the sector still faces issues like water scarcity and pollution, which threaten the sustainability of aquaculture practices. Integrated systems, such as rice-fish farming, help mitigate some of these challenges by utilizing existing agricultural infrastructure to rear fish, thus reducing water usage (Rakotomanana, 2018).

The development of aquaculture in Antsirabe is hindered by several challenges, including land tenure insecurity, limited access to training, and financial constraints (UNDP, 2020). Only 40% of farmers have received formal training, with the majority relying on traditional knowledge passed down through generations (World Bank, 2019). The lack of access to modern technologies and the high cost of upgrading facilities further complicate the situation, limiting the potential for growth in the sector (Andrianaivoarisoa & Rabetaliana, 2020).

To address these challenges, various support projects have been initiated by both the government and international organizations. These initiatives focus on improving infrastructure, providing continuous training, and facilitating access to financing for small-scale farmers (IFAD, 2022). The promotion of sustainable practices, such as polyculture and integrated farming systems, is essential to ensure the long-term viability of aquaculture in Madagascar (FAO, 2021).

Furthermore, enhancing the technical capacity of farmers through regular training and workshops could significantly improve productivity and reduce environmental impacts (Andriatsarafara et al., 2019). Access to better-quality inputs, particularly fry and commercial feed, would also contribute to higher yields and more sustainable fish farming operations (World Bank, 2019).

IV. Conclusions

The study reveals that farmers who combine traditional techniques and technologies see significant improvements in productivity. However, further research is needed to adapt these techniques to larger scales, taking into account the specificities of each species and local environmental conditions.

References

Andrianaivoarisoa, H., & Rabetaliana, H. (2020). *Tilapia farming in Madagascar : Strategies for sustainable production*. Journal of Aquaculture in Africa, 23(2), 112-123.

Andriatsarafara, F., et al. (2019). Farming techniques and performance of fish species in Madagascar. Review of Aquaculture and Fisheries, 7(1), 45-58.

FAO. (2021). *Aquaculture development in Madagascar*. Fisheries and Aquaculture Circular No. 1182. Rome : FAO.

IFAD. (2022). Aquaculture Development Project in Madagascar: Final report. Rome: International Fund for Agricultural Development.

Rakotomanana, A. (2018). *Fish polyculture in Madagascar : Opportunities and challenges*. Malagasy Rural Studies, 15(4), 78-92.

Rakotonirina, R., et al. (2016). Improving fish pond management in Madagascar. Journal of Rural Economics, 10(2), 123-135.

Ralambomanana, T. (2017). *Fish farming and sustainable water management in Madagascar*. Malagasy Journal of Agriculture and Environment, 12(3), 89-101.

Razafindralambo, V. (2021). Integrated farming in Madagascar: Socio-economic and environmental impacts. Agricultural Research Journal, 19(1), 56-68.
UNDP. (2020). *Support to Sustainable Aquaculture in Madagascar*. New York: United Nations Development Programme.
UNDP. (2020). Support to Sustainable Aquaculture in Madagascar. New York: United
World Bank. (2019). Aquaculture in Africa: Madagascar's Role in the Blue Economy. Washington, DC: World Bank.