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Hydrological Potential of the Ifaho River and Agricultural Constraints in Soanierana (Tolagnaro): Diagnosis and Development Perspectives

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ABSTRACT

Agricultural production in Soanierana, in the Tolagnaro District of south-eastern Madagascar, remains limited despite the presence of the Ifaho River, which represents an important water resource. This study aims to assess the hydrological potential of the Ifaho River and to identify the main constraints affecting agricultural development in the area. The analysis is based on the interpretation of existing hydrological data, rainfall records, and field observations carried out among local farming systems. The results show that the region receives about 1,200 mm of rainfall per year and that the river experiences frequent flooding, indicating a significant but underutilized water potential. Nevertheless, rice yields remain low, averaging 0.96 t/ha, mainly due to insufficient irrigation infrastructure, limited access to agricultural inputs, and high climatic variability. Human activities, particularly sand extraction from the riverbed, also contribute to local disturbances in water availability. The estimated annual discharge of the sub-catchment reaches 2,171,516,400 m³/year, confirming the feasibility of improved water control. The study recommends the development of adapted irrigation systems, better management of river resources, and strengthened resilience of agricultural practices to climatic hazards.

Keywords: agricultural development; hydrological potential; Ifaho River; irrigation; rice production; Tolagnaro.

1 INTRODUCTION

The Ifaho River, located in the municipality of Soanierana in the Tolagnaro District of south-eastern Madagascar, forms a sub-catchment with considerable hydrological potential for local agricultural development. Available studies report an average annual discharge of about 2,171,516,400 m³/year, with flood peaks exceeding 1,000 m³/s. These figures reflect the presence of an abundant water resource that remains largely underutilized (Rakotondraibe, 2017 ; Chaperon et al., 1991). This situation is not unique to the study area, as Madagascar still faces major challenges in mobilizing its irrigable potential, mainly due to insufficient infrastructure, low agricultural intensification, and high exposure to climatic hazards (FAO, 2021). In the fokontany of Ampasy Morafeno, the estimated cultivable area reaches approximately 350 ha. However, only about 65% of this land is currently exploited, largely because of limited access to irrigation water. As a result, rice yields remain low and show strong variability from one agricultural season to another. This situation highlights a clear mismatch between water availability and agricultural performance. Addressing this paradox requires a detailed analysis of the hydrological functioning of the Ifaho River and its interaction with local agricultural practices. Such an approach allows the identification of technical, structural, and climatic constraints that limit optimal land use, while also assessing the real potential for irrigation development and agricultural infrastructure improvement.

Within this context, the objectives of the present study are to: (i) analyze the hydrological potential of the Ifaho River; (ii) characterize the main agricultural constraints in Soanierana; and (iii) propose development perspectives aimed at improving water use efficiency, strengthening food security, and enhancing the resilience of production systems within the sub-catchment.

1.1 STUDY AREA

The study was conducted in the *fokontany* of Ampasy Morafeno as shown in Figure 1, located near the Ifaho Bridge in the municipality of Soanierana, approximately 8 km north-west of the city of Tolagnaro (south-eastern Madagascar) (Head of *fokontany*, 2025 data). The area is characterized by a humid tropical climate, typical of the Tolagnaro region, which is favorable to the development of both irrigated and rainfed crops (Former officer of the Ministry of Agriculture, Fort-Dauphin, 2025 data). From a demographic perspective, Ampasy Morafeno has a population of 1,991 inhabitants distributed among 413 households, the majority of whom depend on agriculture as their main source of subsistence and income (Head of *fokontany*, 2025). The Ifaho River sub-catchment associated with this *fokontany* includes approximately 350 hectares of potentially cultivable rice fields, characterized by fertile soils and a significant irrigation potential (Former officer of the Ministry of Agriculture, 2025). This configuration makes Ampasy Morafeno a relevant site for studying the hydrological

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potential of the Ifaho River and its impact on local agricultural production.



Figure 1: Location of the study area (Soanierana, Tolagnaro District)

1.1.1 POPULATION HISTORY OF AMPASY-MORAFENO

The indigenous ethnic group of Ampasy Morafeno is the Antesaka, originally from Manambondro–Farafangana, located approximately 770 km away, or about 13 hours by road via National Road RN12a. This community migrated to Ampasy Morafeno in search of agricultural land, locally referred to as *"tany lonake"*, in order to secure their livelihoods. This movement is part of an economically driven migratory dynamic motivated by the search for new fertile lands suitable for agriculture. According to Suzanne Vianès (1959), a major collective migration of the Antesaka from the Vangaindrano region to Anosy took place during the 19th century, in a context of political and territorial pressure linked to Merina expansion. These population movements, often carried out by family or community groups, contributed to the long-term settlement of the Ampasy Morafeno plain. Despite their long-term settlement in Ampasy Morafeno, the inhabitants maintain strong ties with their ancestral land. According to tradition, they regularly return to Manambondro to bury the *ombrule*, a specific funeral rite associated with children.

Today, the population is permanently established in Ampasy Morafeno, where it primarily practices rice cultivation as well as market gardening, including tomato, zucchini, cucumber, and pepper. The local landscape is characterized by forest cover, notably lychee and mango trees, reflecting a relatively well-preserved natural environment despite increasing agricultural pressure. This permanent migration illustrates a major economic adaptation of the Antesaka, who successfully settled in a new environment to meet their agricultural development needs. The traditional dwellings of the indigenous populations of Ampasy Morafeno reflect ancestral know-how closely linked to the natural environment (see Figure 1). They are predominantly built using *falafa*, an assembly of woven palm leaves, local wood, and bamboo, and follow an architectural model inspired by the eastern coast of Madagascar. This style, characterized by resistance to humidity, heat, and corrosion, has emerged as an appropriate response to the tropical climate and locally available resources. Lightweight yet robust, these structures derive their durability from mastery of construction techniques often passed down from generation to generation.



(a) (b)

Figure 2: Indigenous populations of Ampasy Morafeno (a) Photograph of the Head of the *Fokontany* of Ampasy Morafeno (b) Traditional dwelling built with *falafa*; photo credit: Author, July 2025

2 LITERATURE REVIEW / RELATED WORK

During our documentation work, we observed that several studies conducted in the Anosy region focus primarily on the hydrology and climate of southeastern Madagascar. Previous research by ORSTOM and other authors has examined hydrological regimes, flood dynamics, and water resource availability in this region (Vianès, 1959; ORSTOM/EDF IGECO, 1963; Chapéron, 1993; Danloux, 1996; Ferry et al., 1998). These studies provided us with a sound understanding of the hydrological functioning of the rivers in southern and southeastern Madagascar, particularly the Ifaho River. While the river can provide a significant amount of water, the lack of irrigation infrastructure severely limits its use for local agriculture.

At the regional level, several reports and development planning documents highlight the importance of water resources for agricultural development, particularly irrigated rice cultivation and off-season crops. As in the study area, these documents emphasize the existence of numerous agricultural constraints such as low levels of hydro-agricultural development, lack of irrigation maintenance, and limited access to agricultural inputs (INSTAT, 2013; INSTAT, 2021; PRD Anosy, 2021; FAO, 2015). By comparison, some areas of the watersheds in several African countries experience these same major problems, which limit agricultural development in areas with high hydrological potential (You et al., 2011; Chinsinga, 2012; and Peters, 2006). Other recent authors confirm the need for targeted policy interventions to optimize irrigation and improve

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agricultural productivity and water resource management (Kenford et al., 2026).

This existing literature provides important information on hydrology, climate, and agricultural development, but few studies offer an integrated analysis of the relationship between a river's hydrological potential, irrigation systems, and agricultural performance at the local level. However, agricultural development in rural areas is highly dependent on water management and the efficiency of irrigation systems (Raymond et al., 2019). It is within this context that the present study is situated, aiming to provide a diagnosis and development perspectives for the local hydro-agricultural system.

3 METHODOLOGY

To achieve the objective of this research, the study relied on three complementary methods. It began with a series of documentation tasks at university libraries and regional technical services. After collecting baseline information on the study area, fieldwork was conducted in the Ampasy-Morafeno intervention fokontany to carry out participatory surveys with farmers. The collected data were entered and processed using Excel files.

3.1 DOCUMENTARY RESEARCH

3.1.1 COLLECTION OF GENERAL REFERENCES

The collection of general bibliographic sources was carried out in several university institutions and documentation centers, providing access to regional and national publications on hydrology, agriculture, climatology, and natural resource management. At the University of Toliara, research was conducted at the Tsiebo Calvin Library, the CEDRAToM Library (Center for Documentation and Research on Spatial Planning and the Environment), the GPCEHP Doctoral School Library, as well as the Alliance Française Library. Upon arrival in Tolagnaro, the documentary review continued at the Saint-Jacques Catholic Mission and the Alliance Française of Fort-Dauphin, which provided access to books and reports focusing on regional hydrology, local agricultural systems, and interactions between water resources and agricultural production in the Anosy Region and the extreme southern part of Madagascar. All these institutions allowed consultation of general documents on physical and human geography, as well as specialized sources related to the development of irrigated schemes, rainfall variability, and flood management in rice-growing and market-gardening areas.

3.1.2 COLLECTION OF SPECIALIZED REFERENCES

The targeted collection focused on documents and information obtained from local authorities and regional institutions involved in agriculture and water management. Offices of the Anosy Region, agricultural technical services, and specialized staff provided up-to-date data on agricultural production, irrigated areas, cropping techniques, and the condition of hydraulic infrastructure. This approach made it possible to obtain precise information on the functioning of the Ifaho River, its discharge, the rice and market-gardening potential of the sub-catchment, as well as the technical and institutional constraints limiting optimal land use. The integration of these two components general and specialized documentary research provided a solid framework for analyzing hydrological potential and agricultural constraints, by combining theoretical knowledge with local field data to formulate relevant recommendations for sustainable development and efficient water management.

3.2 3.2. FIELD SURVEY

During the field visit, a courtesy call was made to the fokontany chief to introduce ourselves and explain the objectives of the study. This meeting allowed us to gather specific information on the demographics, agricultural constraints, and hydrological regime of the Ifaho River. The fokontany chief also facilitated our integration into the community. Subsequently, a household census was conducted in the study area. The results of this census served as the basis for determining the sample size of households to be surveyed. This sample size was determined using the following formula by Taro Yamane (1967):

$$n = \frac{N}{1 + N * e^2} \quad (1)$$

Where:

***n*:** sample size

***N*:** population size (total number of households)

***e*:** margin of error (level of precision)

In this study, we have:

***N*:** 120 households

***e*:** 10% (or 0.1)

Thus,

$$n = \frac{120}{1 + (120 * (0.1)^2)} = 55 \ households$$

In total, household surveys will be conducted with 55 target households.

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3.3 METHODS OF DATA COLLECTION AND ANALYSIS

A household survey was conducted using systematic sampling based on a constant sampling interval, with a random starting point, following a preliminary household count. Specifically, two main data collection methods were implemented during the household surveys. The first consisted of counting the total number of households in the Fokontany (village). Based on this count, systematic sampling was adopted to ensure a homogeneous distribution of surveyed households within the study area.

The sampling interval was defined to select every other household. Thus, after the first household was randomly selected, subsequent households were chosen at regular intervals (household 1, household 3, household 5, etc.) until the sample size of 55 households was reached. The first household to be surveyed was chosen randomly using the starting point method, which involves rotating a pen 360 degrees and selecting the first house indicated as the first household to be surveyed. Due to the absence of some heads of household during the initial visits, several visits (three in total) were necessary to complete data collection and ensure the representativeness of the sample.Following this data collection phase, the raw data from the survey forms, including demographic, social, and agricultural information, as well as data related to water sources and infrastructure, were entered and processed using an Excel file. This processing allowed for data classification, the creation of tables and graphs, and the development of quantitative analyses. This approach also enabled the linking of field observations to the quantitative analyses conducted within the framework of the study.

4 RESULTS

This section will present the analysis of the hydrological potential of the Ifaho River, focusing particularly on flooding and flow velocities, as well as the main agricultural constraints faced by local farmers.

4.1 HYDROLOGICAL POTENTIAL OF THE IFAHO RIVER

Geographically, the small Ifaho sub-catchment is located on the eastern flank of the Anosy mountain ranges, northwest of Tolagnaro. It primarily rests on the ancient granites of Anosy, locally weathered into granite sands, forming poorly developed lithosols (Chaperon et al., 1993).

4.1.1 FLOODS

Hydrological studies carried out at the Ifaho–Fanjahira station between 1962 and 1974 characterize the river's hydrological regime. To analyze the annual distribution of mean floods, data from 1962–63 and 1974–75 were considered as shown in Table I.

TABLE I: .ANNUAL MAXIMUM FLOODS RECORDED AT IFAHO–FANJAHIRA STATION (IN M³/S)

Years	Q (m3/s)	Date
1962-63	481	04/01/63- 18h00
1963-64	1210	02/03/64- 18h00
1964-65	460	25/01/65- 06h00
1965-66	89	21/08/66- 18h00
1966-67	343	07/03/67- 06h00
1967-68	105	04/11/67- 21h00
1968-69	267	11/02/69- 06h00
1969-70	750	19/02/70- 12h00
1970-71	1160	02/02/71- 12h00
1971-72	597	14/03/72- 06h00
1972-73	505	19/11/72- 21h00
1973-74	445	31/12/73- 21h00
1974-75	209	25/01/75- 12h00

Source : Chaperon *et al*, 1993

These observed values show several trends:

i. Very high flood peaks are recorded, notably in 1963–64 (1,210 m³/s) and 1970–71 (1,160 m³/s), confirming the high responsiveness of the watershed and its significant hydrological potential. In some years, substantial floods occur even during the dry season (for example, August 1965–66), likely due to delayed infiltration, slow groundwater recharge, or concentrated runoff.

ii. The average annual discharge is estimated between 8.73 and 13.3 m³/s, indicating an abundant and renewable water resource.

iii. Annual maxima regularly exceed 1,000 m³/s, giving the river considerable capacity for irrigation, small-scale hydropower, and domestic uses. The estimated mean annual flood discharges at the Ifaho-Ifanjahira site are presented in the Table II.

TABLE II:.ESTIMATED MEAN ANNUAL FLOOD DISCHARGES AT IFAHO–FANJAHIRA (IN M³/S)

Parameters	Quantity (m^3/s)	Q l/s/km²
2-year flood	430	2190
5-year flood	735	3750
10-year flood	960	4900
50-year flood	(1540)	(7860)

Source : Chaperon *et al*, 1993

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Due to its location in a humid environment in the Anosy region, the Ifaho sub-basin, covering an area of 196 km² (coordinates: 46°53′46″ E and 24°54′36″ S), constitutes a strategic resource for local agricultural development. Rakotondraibe (2017) estimates that the annual discharge at the outlet reaches approximately 2,171,516,400 m³/year, reflecting considerable water potential. The available water quantity and the estimated usable volume irrigation are presented in the Table III.

TABLE III: AVAILABLE WATER VOLUME IN THE IFAHO–FANJAHIRA SUB-BASIN (FANJAHIRA)

Parameters	Discharged Water Volume	Irrigation Water Requirement for Ampasy-Morafeno Rice Fields	Remaining Water Volume in Ifaho after Irrigation
Value (m³/year)	2 171 516 400	3.500.000	2 168 016 400
Area	196 km2	350 ha	00
Rate (%)	100	0,16	99,84

Source : Razafindrakoto.H, 2017

A simulation for the *fokontany* of Ampasy-Morafeno, with 350 ha of rice fields, indicates that the entire area could be irrigated with only 3.5 million m³/year, assuming an average consumption of approximately 10,000 m³/ha/year for rice cultivation, according to FAO estimates for lowland irrigated systems (FAO, 2021). This would leave more than 2,168 million m³/year unused, illustrating the extent of untapped water potential. These findings highlight that the Ifaho–Fanjahira sub-basin possesses a largely underutilized water reservoir.



(a) (b)

Figure 3: Ifaho Bridge and associated river hydrological conditions (a) Ifaho Bridge, (b)Water level and condition of the Ifaho River during the dry season (July 2025)

Source photo: Author, July 2025

For comparison, the Tsiazompaniry dam (Analamanga), according to ORSTOM / EDF Igeco (1963), has a storage capacity of 260 million m³, representing only about 12% of the annual volume of the Ifaho, yet it enables efficient irrigation of the Ikopa basin. This comparison highlights the exceptional water potential of the Ifaho sub-basin, which could be more effectively utilized through structured water management. The establishment of regulation and redistribution infrastructures could mobilize this resource efficiently, secure irrigation, improve agricultural yields, and strengthen the resilience of local systems against climatic hazards.

The volume of water allocated for irrigation at Tsiazompaniry as well as the remaining water volume are reported in the Table IV.

TABLE IV: AVAILABLE WATER VOLUME AT TSIAZOMPANIRY (ANALAMANGA)

Parameters	Discharged Water Volume	Irrigation Water Requirement for Tsiazompaniry Rice Fields	Remaining Water Volume in Tsiazompaniry Irrigation
Value (m³/year)	260 000 000	53.000.000	207 000 000
Area	31 km2	ND	00
Rate (%)	100	20,4	79,6

Source : ORSTOM / EDF-Igeco (1963)

5 DISCUSSION

5.1 ANALYSIS OF AGRICULTURAL CONSTRAINTS

In the study area, the results obtained reveal several major agricultural constraints. Table V list these study results.

TABLE V : MAIN CONSTRAINTS PERCEIVED BY FARMING HOUSEHOLDS

Main agricultural Contraits	Yes	%	No	%	Don't Now	%
No hydro-agricultural infrastructure (irrigation dam)	51	93	2	4	2	4
Period of lack of access to irrigation water						
Dry Saison (Avril-Octobre)	48	87	5	9	2	5
Rainy Saisons (Novembre-Mars)	15	27	38	69	2	4
Lack of acces to agricultural inputs	45	82	7	13	3	5
Low agricultural yields	42	76	10	18	3	6
Climate variability (drought, floods)	39	71	12	22	4	7
Crop pests and diseases	31	56	20	36	4	8

Source : household survey, july 2025

According to Table V, 93% of respondents (51 out of 55) consider the lack of hydro-agricultural infrastructure (a

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hydro-agricultural dam) to be one of the main constraints to agricultural development in the Fokontany Ampasy-Morafena, Isoanierana commune, despite the presence of the Ifaho River, which is potentially usable year-round (perennial). This lack of a hydro-agricultural dam limits irrigation during the dry season, leaving a large portion of the fields fallow during this period. Furthermore, 87% of respondents (48 out of 55) indicated that the lack of access to irrigation water is particularly acute during the dry season (April-October), when rainfall in southern Madagascar is scarce and no longer allows for the natural irrigation of rice fields. Indeed, 69% of respondents (38 out of 55) highlighted that the problem of access to irrigation water is not noticeable during the rainy season (November-March). Others, 39 out of 55, emphasized that climate variability is one of the main causes of agricultural development problems. Furthermore, a minority of farmers with financial resources convert their rice fields to vegetable crops (spinach, lettuce, tomatoes, beans) to generate income during the harvest period. In addition to these hydrological constraints, other major obstacles were identified, including a lack of access to inputs, as well as insect pests and crop diseases. Fermers' perceptions of the water sources used are reported in the Table VI.

TABLE VI: IRRIGATION WATER SOURCES PERCEIVED BY FARMERS

Categories	Irrigation water Sources / infrastructure	Yes	%	No	%
Water Soruces	Ifaho river	50	91	5	9
Water Soruces	Tradutional wells	18	33	37	67
Water Soruces	Borme fontaine	0	0	0	0
Infrastructure	Traditional channel	50	91	5	9
Infrastructure	Hydroagricultural dam	0	0	55	100

Source : household survey, july 2025

According to table 6, the Ifaho river is the main source of irrigation water in the Fokontany Ampasy-Morafeno. The study indicates that 91% of responents, or 50 out of 55, stated that they primarily use it to irrigate rice fields.

Irrigation is carried out using traditional canals, according to 50 out of 55 people interviewed. In other words, traditionally, water from the Ifaho river is diverted to agricultural plots through local infrastructure. However, this technique remains rudimentary and is insufficient to cover all 350 hactares of irrigable land in the area. Consequently, agricultural production remains significantly below the average of 0,96 tons per hertare in Madagascar. In parallel, 33% of them use traditionnal wells dug by the landowners (18 out of 55). However, no farmer uses a public standpipe or irrigation dams because these infrastructures are not yet available in the area. Thus, the agricultural probleme is not related to a lack of water resources, but rather to the absence of hydroagricultural infrastructure to store, regulate, and distribute river water.

5.2 LINK BETWEEN HIGH RAINFALL, THE SUSTAINABILITY OF THE IFAHO RIVER, AND LOW AGRICULTURAL PRODUCTION:

Historical and recent data show that the Ifaho region experiences significant rainfall variability from year to year. This directly impacts the sustainability of the Ifaho River. The table VII illustrates this rainfall variability.

TABLE VII: AVERAGE ANNUAL RAINFALL CALCULATED OVER 60 YEARS

Years	Rainfall (mm)
1935–1944	1 451
1945–1954	1 640
1955–1964	1 575
1965–1974	1 923
1974- 1984	1 615
1985-1994	1420

Source : L.Ferry et al, 1998

Ferry et al. (1998) calculated annual rainfall averages over approximately 60 years, with an overall mean of around 1,711 mm/year. These values illustrate a rainfall regime characterized by notably wetter phases (especially 1965–1974) and relatively drier periods. Justin R. (2023) reported the annual rainfall at the Ifaho-Soanierana site, which is detailed in the Table VIII.

TABLE VIII: ANNUAL RAINFALL AT IFAHO-SOANIERANA

Years	Rainfall (mm)
2009	1123
2010	862
2011	1160
2012	1021
2013	1068
2014	980
2015	960
2016	468
2017	1040
2018	773
2019	1343

Source : Justin R. (2023)

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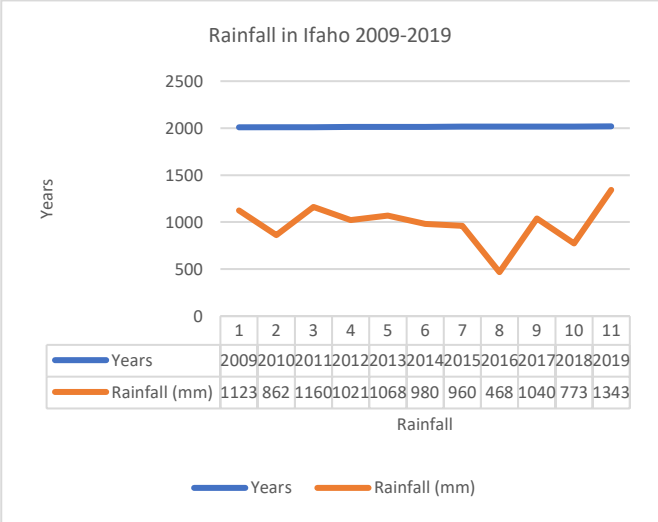


Figure 4. Rainfall in Ifaho-Soanierana

Its level during the rainy season, coupled with the lack of hydro-agricultural infrastructure to store and regulate water, severely limits its use for irrigation. The riverbed remains full of water year-round. Indeed, due to the absence of suitable irrigation systems, this resource cannot be effectively used to support agricultural production. Consequently, farmers are experiencing a considerable decrease in rice production, estimated at 0.96 tons per hectare.

5.3 ALTERNATIVE SOLUTIONS ADOPTED BY THE COMMUNITY

5.3.1 VEGETABLE FARMING:

Facing persistent irrigation problems in the rice fields of the Ampasy Morafeno area, farmers have turned to vegetable farming as an alternative solution, offering short-term profitability. The choice of crops mainly focuses on petsay (Chinese cabbage), supplemented by onions and lettuce—short-cycle plants. These crops have the advantage of rapid growth and regular production, allowing farmers to generate almost immediate income and maintain some cash flow.

For example, petsay germinates quickly and can be transplanted in nurseries or directly under shelter after about a week. Harvesting can begin as early as 4 to 6 weeks after sowing, with successive cuttings every 15 days over several months. This fast rotation optimizes plot usage and provides continuous production throughout the season. However, these vegetable crops are exposed to significant pests, locally known as Tsikarake (small beetles or sucking aphids) and Remorque (insects that can chew leaves or infect young shoots). These pests weaken the plants, cause leaf yellowing or drying, and can lead to significant yield losses. To mitigate these impacts, farmers use integrated pest management methods, including regular crop monitoring, handmade traps (bottle traps, leaf shaking), and targeted mechanical interventions. In terms of profitability, a well-maintained vegetable plot can generate an income of 100,000 to 150,000 Ariary per cycle, providing a valuable supplementary income given the uncertainties of rice cultivation.



Figure 5: Women's agricultural activities in the study area (a) Bean cultivattion field in full growth stage (b) Female farmer weeding a bed of petsay (leafy green vegetables).

Source photo: Author, July 2025

5.3.2 RIVER SAND EXTRACTION

River sand extraction constitutes another major economic activity in Ampasy Morafeno, engaging a significant portion of the population, both men and women. This activity, carried out directly in the bed of the Ifaho River, provides a quick and accessible source of income, especially in the context of food insecurity and seasonal agricultural constraints. Sand is mainly collected using dugout canoes, which allow access to deeper areas where the sand quality is optimal. Villagers organize themselves to gradually accumulate the required volumes for sale. A 10-ton truckload is generally sold for 50,000 ariary, while larger loads of 15–20 tons reach prices between 120,000 and 150,000 ariary per shipment. On average, 8 to 10 trucks leave the site daily to transport sand to Fort-Dauphin. This activity is driven by strong urban demand, with the city of Fort-Dauphin sourcing directly from local extractors. The sand is primarily used for construction works, including roads, buildings, and public infrastructure. Although profitable in the short term, sand extraction raises significant environmental concerns. It contributes to riverbank erosion, destabilization of riverbeds, and disruption of the Ifaho's natural flow, with potential consequences for biodiversity and water availability for agriculture.

6 CONCLUSION

Cette This study highlighted the significant hydrological potential of the Ifaho River, which records up to 217,151,640 m³ of water per year, and the agricultural constraints in the Fokontany of Ampasy-Morafeno. These agricultural constraints include the lack of an irrigation system (hydro-agricultural dam), limited access to water during the dry season, and a shortage of agricultural inputs. Despite a sufficient annual water volume to irrigate 350 hectares of rice paddies, production remains low. Annual production is estimated at 0.96 tons. To ensure sustainable agricultural

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development and strengthen food security, this study suggests strategic approaches in the short, medium, and long term.

In the short term, farmers must be provided with agricultural inputs and equipment to improve the efficiency of traditional practices. Furthermore, training and awareness workshops on adapted farming techniques must be organized for farmers. In the medium term, small-scale irrigation infrastructure, such as storage reservoirs and canals, must be developed to efficiently utilize the water available throughout the year. An integrated water management plan must be established in accordance with the Water Code (Articles 75 and 76) and Decrees No. 2003-191 and No. 2003-192 to plan irrigation during dry periods and regulate flooding.

In the long term, a major irrigation dam must be constructed to secure the water supply and allow for the expansion of arable land. The Ifaho agricultural hub must be strengthened as an integrated center capable of stimulating the local economy and food security. Implementing these recommendations would increase rice production in the Fokontany of Ampasy-Morafeno.

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