Photo credit: Front cover, Sunil N. Siriwardena/WorldFish

Inland valley swamp assessment in Tonkolili District, Sierra Leone

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

USAID
FROM THE AMERICAN PEOPLE

CGIAR
RESEARCH PROGRAM ON Fish

WorldFish

Inland valley swamp assessment in Tonkolili District, Sierra Leone

Authors

Augustine Bunbu Rashid-Noah,[1] Michael Johnny,[2] Julius Olapade,[1] Michael J. Phillips[3] and Sunil N. Siriwardena[3]

Authors' Affiliations

[1] Njala University, Sierra Leone
[2] Independent consultant, Freetown, Sierra Leone
[3] WorldFish, Penang, Malaysia

Citation

This publication should be cited as: Rashid-Noah AB, Johnny M, Olapade J, Phillips MJ and Siriwardena SN. 2018. Inland valley swamp assessment in Tonkolili District, Sierra Leone. Penang, Malaysia: WorldFish. Program Report: 2018-01.

Acknowledgments

This work was undertaken as part of the CGIAR Research Program on Fish Agri-Food Systems (FISH). This publication was made possible by the support of the American people through the Feed the Future program of the United States Agency for International Development (USAID).

Disclaimer

The contents of this publication are the sole responsibility of WorldFish and do not necessarily reflect the views of USAID or the United States Government.

Contents

List of figures

List of tables

List of plates

List of abbreviations

AED	Agricultural Engineering Division (of MAFFS)
CARD	Coalition for African Rice Development
CARE	Cooperative of American Relief Everywhere
CP	crude protein
FAO	Food and Agriculture Organization of the United Nations
FSA	financial services association
GoSL	Government of Sierra Leone
IAA	integrated aquaculture and agriculture
IADP	integrated agricultural development project
IFAD	International Fund for Agricultural Development
INGO	international nongovernmental organization
IVC	Inland Valley Consortium
IVS	inland valley swamp
KII	key informant interview
LRSP	Land Resources Survey Project
LWDD	Land and Water Development Division (of MAFFS)
MAFFS	Ministry of Agriculture, Forestry and Food Security
MFMR	Ministry of Fisheries and Marine Resources
MHS	Ministry of Health and Sanitation
NA	not applicable
NCU	National Coordinating Unit (of the IVC)
NGO	nongovernmental organization
NUC	Njala University College
RRS	Rice Research Station
SATS	Sierra Agricultural and Technical Services
SLARI	Sierra Leone Agricultural Research Institute
SLL	Sierra Leonean Leone
SNAP	Sustainable Nutrition and Agriculture Promotion
ToR	Terms of Reference
WARDA	West Africa Rice Development Association

Definitions and terms

Developed IVS
A swamp in which water control structures have been constructed and/or installed. Such structures generally include a head bund, peripheral canals, a main drain, an overflow/weir and plots separated by internal bunds. In Sierra Leone, swamps are developed primarily for the cultivation of rice under flooded conditions.

Fully developed IVS
A swamp that has all the above structures, allowing full water control.

Partially developed IVS
A swamp that has some of these structures, allowing some degree of water control, with some native vegetation still present in the swamp.

Partly developed IVS
A swamp that has part of its surface area fully or partially developed while the other part is not developed.

Executive summary

Inland valley swamps (IVSs) form part of the upland-inland valley continuum in Sierra Leone, occupying the lowest position in the landscape. They are found in every district in the country and make up its largest lowland ecology, covering an estimated area of 690,000 ha. Because of their wide geographic distribution, generally favorable water regime, higher level of fertility and the potential for simultaneously practicing other agricultural production activities, IVSs are very attractive to the government's intervention to increase food production in the country. Since the 1930s, the policy of the Government of Sierra Leone (GoSL) has been to intensify the cultivation of IVSs to increase the production of rice, the country's staple food crop, to the level of self-sufficiency. Several integrated agricultural development projects (IADPs) were initiated in all regions of the country, most of which have included IVS development and use components. The results of these efforts, however, were disappointing, since the goal of rice self-sufficiency remains elusive and importing rice is still the norm. Other efforts toward promoting intensive IVS use for food production and income generation included the incorporation of fish culture into the farming system. Several schemes were introduced in the north and south of the country. As with the IVS development projects, however, the schemes were not sustainable because of a lack of input supply and knowledge transfer on proper practices.

Several factors have hindered the sustained use of IVSs: (a) an inadequate knowledge base for people (particularly potential investors in the agricultural sector) to plan for the full use of IVSs, (b) limited knowledge of the biophysical, hydrological and socioeconomic characteristics of IVS use, (c) inadequate technical capacity for IVS development for multiple uses, and (d) high labor and other production input requirements for IVS development and use. Further more, the development of aquaculture in the country has been fraught with obstacles, including poor aquaculture development policies, few fish farming traditions, inappropriate technologies and approaches, inadequate input supplies, a lack of genetically proven fish seed, nonfunctional government aquaculture stations, an absence of extension services, and weak support services.

Against this backdrop, an assessment of IVSs was carried out to determine opportunities for diversification and improvements in IVS productivity to enhance food, income and nutritional outcomes for dependent communities living in Tonkolili, one of the poorest and more nutritionally challenged districts in Sierra Leone.

The study was carried out in all 11 chiefdoms of Tonkolili District to establish a knowledge base of the physical characteristics of IVSs, as well as the socioeconomic and aquaculture aspects of their use, and to analyze their agro-potential for integrated farming systems. The methodology applied in this assessment comprised collation of documented literature, a survey of IVS users with standardized questionnaires and focus group discussions (FGDs), and mapping of IVS locations with GPS software. The survey was administered to a sample of 600 household heads using IVSs. The main findings of the study are summarized as follows:

- IVSs are one of the most important ecological resources in Sierra Leone. They provide many economic benefits to their associated communities, from crop farming and fish farming to foraging and hunting.

- The predominant economic activity in Tonkolili District is farming. This fact underscores the importance of developing this sector if income levels in the district are to be raised.

- The level of people's involvement in fish farming activities in the district is low, which is a reflection of the limited state of aquaculture development throughout the country.

- The majority of the IVSs in the survey are seasonal. A high proportion of perennial swamps are found in the northeastern chiefdoms of the district, and these chiefdoms generally have a favorable water regime (prevailing pattern of water flow over a given time) for interventions in crop production and fish culture.

- Because of communal ownership, IVS communities are not constrained by adequate access to land for their farming needs. Nearly all farmers (97%) can access and use IVSs, primarily for cultivation of crops, though high labor requirements and the need for access to production inputs act as barriers to intensive use.

- The intensity of use varies across communities and seasons. This occurs primarily during the rainy season, since only a few farmers cultivate crops during the dry season.

- This study revealed high, unused agro-potential in the IVSs of Tonkolili District. From a hydrological standpoint, there is potential for interventions to intensify the development and use of IVSs for food production, especially in areas with perennial swamps or swamps with water residency up to 8–9 months. A significant proportion of IVSs falls into the latter water residency category.

- Considering the significant extent of IVS availability in the district (54,650 ha), with rice as the primary cultivated crop, there is enormous potential for integrated rice-fish farming to increase income as well as food and nutritional security.

The report concludes with several recommendations for interventions to optimize the use of IVSs in Tonkolili District to enhance food production, nutrition and income.

Introduction

Background: Review of current knowledge on the status and use of IVSs in Sierra Leone

This review is based on information garnered from various documents of the Ministry of Agriculture of the GoSL, consultancy reports, reports by the Consortium for the Sustainable Use of Inland Valley Agro-ecosystems in sub-Saharan Africa, reports by the National Coordinating Unit (NCU) of the Inland Valley Consortium (IVC), of which Sierra Leone was a member, and the Land Evaluation Report of the Land Resources Survey Project (LRSP). Specific references are cited where appropriate.

Arable land potential and distribution

Sierra Leone covers a total land area of 72,325 km^2, of which nearly 75% is arable. This arable land is distributed between two main ecologies: the upland and the lowland, which comprise 78% and 22% of the arable land, respectively. The upland is composed of forest, savannah woodlands and grasslands, while the lowland contains 690,000 ha of IVSs, 145,000 ha of *bolilands* (large, saucer-shaped basins), 130,000 ha of riverine grasslands and 200,000 ha of mangrove swamps.

Table 1 shows that IVSs are the second-most prevalent ecosystem in the country, behind only the upland. IVSs account for 13% of arable land and 59% of all lowland ecologies, and they also constitute about 60% of the lowland area devoted to growing rice, the country's staple food crop. The prominence of IVSs as a lowland ecology, their potential for high yields and their ubiquitous distribution in the country make them an attractive option for rice, fish culture and vegetable production in Sierra Leone.

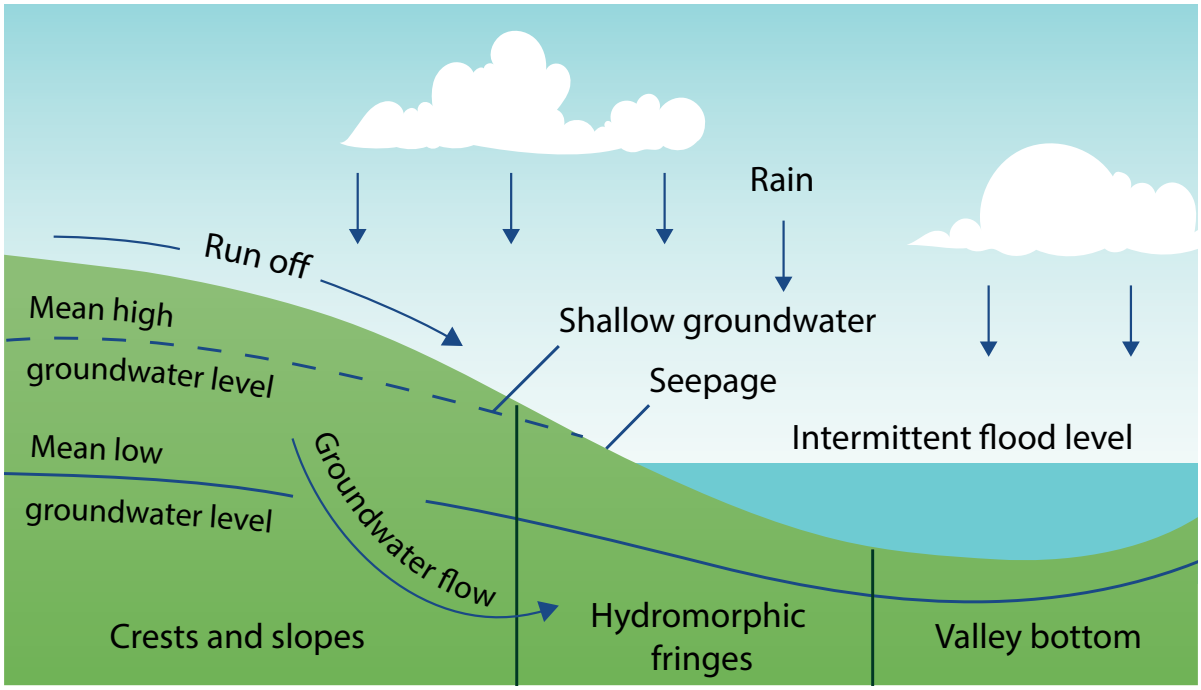
Ecology	Ecosystem	Area (ha)	% of arable land	% of total land area
Upland	Upland	4,200,000	78	58
Lowland	IVS	690,000	13	10
	Mangrove swamp	200,000	4	3
	Bolilands	145,000	3	2
	Riverine grasslands	130,000	2	2
	Arable land	5,365,000	100	75
	Non-arable land	1,870,000		25
Grand total		**7,235,000**		**100**

Source: Land and Water Development Division, Ministry of Agriculture, Forestry and Food Security, 2005

Table 1. Distribution of arable land in Sierra Leone.

Physical and hydrological characteristics of IVSs

IVSs form the lowest part of the inland valley continuum, which comprises the upland crest and slopes, the hydromorphic zone and the valley bottom (Figure 1). The hydromorphic zone is the area close to the valley bottom where the groundwater table is sufficiently shallow to be within reach of crops. IVSs occupy the lowest position on the inland valley landscape, and they are part of a drainage network made up of several small streams (perennial or seasonal) that flow into a river downstream. This topographic position renders IVSs prone to flooding by runoff water generated in the upland areas. The period and extent of flooding depends on the size of the upland area contributing runoff, in relation to the size of the valley bottom that receives the runoff, and on the general topography of the catchment. IVSs have a variable water regime that makes them suitable for various purposes, such as rice cultivation and fish culture during the rainy season from May to October and the cultivation of other food crops during the dry season from November to April.

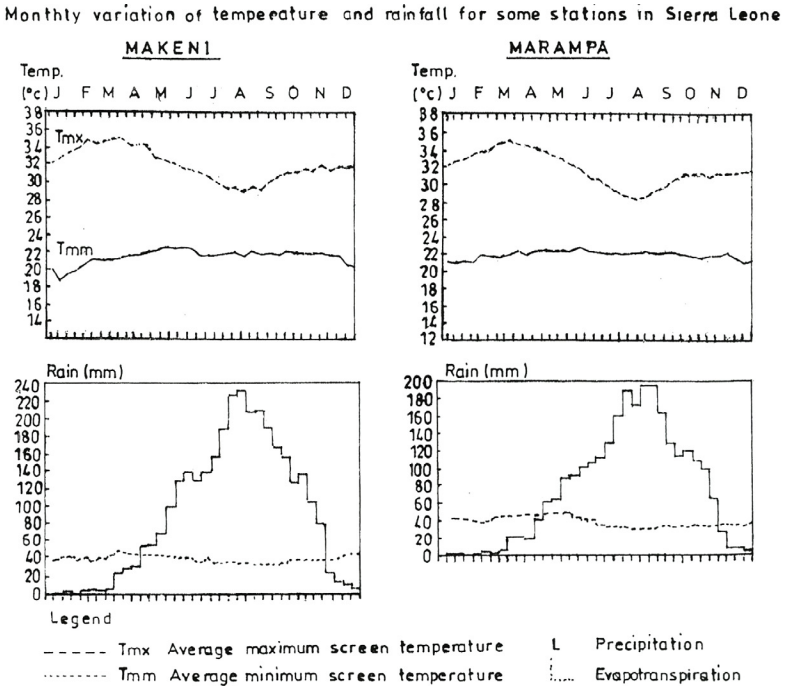


Source: Woperies et al., 2009

Figure 1. Cross-section of an inland valley showing the three zones of the landscape.

The hydrological characteristics of IVSs and other lowland ecologies are influenced largely by the climate of Sierra Leone, which lies in the humid tropics and receives an average annual rainfall of approximately 3000 mm. This rainfall is unevenly distributed throughout the country, ranging from roughly 2000 mm in the north to 4000 mm in the coastal areas (SLARI 2011).

Sierra Leone has two distinct seasons. The rainy season, which lasts from May to October, is characterized by a surplus of water and high runoff rates, and both of these factors cause annual flooding of IVSs and other lowland ecologies. The dry season, which runs from November to April, is characterized by water deficits that limit crop production and other farming activities. The temperature throughout the country is moderately high year-round, with mean monthly values ranging from about 21^{0}C to about 30^{0}C. Figure 2 shows the monthly variations in temperature, rainfall and evapotranspiration for two climate stations located near Tonkolili District.



Source: FAO 1980

Figure 2. Monthly variation for Makeni and Marampa stations.

Not all IVSs are the same in terms of their physical, chemical and hydrological characteristics, so it is necessary to investigate each swamp being targeted for agricultural and/or other types of intervention (Rashid-Noah 1995). Depending on the general morphology of the catchment in which they are located, IVSs can be long and narrow or broad and short, and the slopes of their catchments can be steep or gentle. IVSs also differ in terms of the length of time they remain flooded or retain surface water, which is mainly determined by the hydrogeological characteristics of the catchment. Plates 1–6 below show some general features and modes of using IVSs.

Plate 1. An undeveloped IVS with oil palm trees in the background.

Plate 2. A flooded IVS.

Plate 3. A developed IVS with a main drain, rice plots and internal bunds.

Plate 4. Vegetables grown on mounds in an IVS.

Plate 5. Fishponds and a poultry building at an IVS site.

Plate 6. Water harvesting (dam) for crop production and fish capture in an IVS.

IVSs have been traditionally cultivated since before the 1920s, but improved swamp cultivation started in 1922 in the coastal associated swamps in Northern Sierra Leone when flood protection measures were implemented (Lamin et al. 1999). The Rice Research Station (RRS) in Rokupr was established in 1934 and began IVS research activities in 1966. Prior to this time, IVS cultivation was done with little (if any) understanding of the characteristics of the swamps. No surveys were conducted to inform the design or construction of IVSs for rice cultivation, so it was assumed that all IVSs were the same and could therefore be developed and utilized using identical methods. There was no knowledge base to plan the development and use of IVSs.

However, beginning in the 1970s and continuing into the 2000s, there have been considerable efforts to inventory and characterize IVSs and other land types, both for specific project-related purposes and to develop a base of IVS knowledge. Several organizations have carried out agro-ecological multiscale characterization studies of the upland and IVSs. The organizations include universities, private consulting groups and the Ministry of Agriculture, Forestry and Food Security (MAFFS) of Sierra Leone. Examples of these studies are summarized as follows:

- Odell et al. (1974) synthesized all of the work carried out in the 1960s to classify and characterize soils of select areas in Sierra Leone, and they made recommendations for the adaptation and management of soils in IVSs and the upland.
- Between 1975 and 1979, the LRSP conducted a countrywide reconnaissance survey of soils, vegetation and land use; land facets (i.e. upland, hydromorphic zones and valley bottoms of IVSs) were used as the mapping units for potential agricultural development. This work enabled the production of the first national integrated survey of the land resources in Sierra Leone and led to a broad but specific qualitative evaluation of their potential for agricultural development. The Land and Water Development Division (LWDD) of MAFFS carried out a series of land evaluations during the 1980s and 1990s for project-specific interventions in select areas of Sierra Leone. These evaluations included detailed soil and topographic surveys in more than 100 swamps in various parts of the country for swamp development activities (principally rice production).
- Staff at Njala University College (NUC) carried out early research on the hydrology of the lowlands in the late 1960s as part of its soil survey work. The researchers monitored the flooding characteristics (depth of flooding, areal extent of flooding and groundwater table depth) of two *boliland* swamps. The objective of the research was to collect data that could be used to determine which rice varieties would be best suited to various depths and durations of floods. Although this research was not implemented in IVSs, it developed a methodology that was later used by others to study the hydrology of IVSs. For example, as reported by Rashid-Noah (1999), it was used to study the response of the average monthly discharge from a developed IVS to monthly rainfall inputs from August to December and to study the groundwater table at the edge of the swamp during the same period.
- The first nationwide inventorying and characterization of IVSs were carried out in 1996 by Sierra Agricultural and Technical Services (SATS) in all agricultural and agro-climatic regions of the country. The objective of the study was to identify swamps that were suitable for development. A total of 62 IVSs were selected and surveyed at the reconnaissance level, using their hydrogeological, hydrological and morphological characteristics and associated catchments (SATS 1996). The main criteria used in the selection of these swamps were (a) the security of the area for both the farmers and the investigators and (b) the accessibility of the swamps in relation to the condition of the roads and the time it would take to reach them. The characteristics were rated to determine the physical suitability of each swamp for development. The rating scores were then used to classify the swamps, ranging from Class A (very suitable) to Class D (not suitable). Six IVSs were classified as "very suitable," 21 as "suitable," 23 as "moderately suitable" and 11 as "not suitable." It was not feasible to carry out detailed surveys on all 62 IVSs; rather, the researchers selected a sample of 10 in which to conduct detailed investigations. Observations and measurements were made on land factors such as topography, soil texture, pH and cation exchange capacity, organic matter, total nitrogen and available phosphorous. The land factors were then matched with the growth requirements of some food crops (e.g. rice, cassava, groundnut, maize and sweet potato) to develop an evaluation of the swamps' suitability for growing these crops. The results of the study indicated that the main limitations to crop production in IVSs were soil fertility, moisture regime and soil texture (SATS 1996).
- The Food and Agriculture Organization of the United Nations (FAO) supported an inventory study of IVSs in nearly all districts of Sierra Leone in 2009. The 1047 IVSs that were inventoried had a combined area of 30,220 ha (Rashid-Noah et al. 2009). In Tonkolili District, 133 IVSs were inventoried, of which 118 (88.7%) were perennial, 13 (9.8%) were seasonal with 9–10 months of surface water and 2 (1.5%) were seasonal with 6–8 months of surface water (Rashid-Noah et al. 2009). However, the study did not provide information on the geographic distribution of the swamps within the district.

District	Number of IVSs (% of total per district) and total area (ha) by category		
	Perennial (11–12 months running water	Seasonal	
		9–10 months running water	6–8 months running water
Kambia	80 (88.9%) 2,064 ha	9 (10%) 200 ha	1 (1.1%) 30 ha
Koinadugu	243 (100%) 2,077	0	0
Port Loko	51 (44.3%) 13,215 ha	43 (37.4%) 2,170 ha	21 (18.3%) 1,294 ha
Tonkolili	118 (88.7%) 1,724 ha	13 (9.8%) 153 ha	2 (1.5%) 32
Bo	86 (93.5%) 807 ha	6 (6.5%) 38 ha	0
Bonthe	53 (98.1%) 1,828 ha	1 (1.9%) 12 ha	0
Moyamba	8 (4.8%) 64 ha	159 (95.2%) 1,350 ha	0
Pujehun	28 (82.4%) 823 ha	5 (14.7%) 72 ha	1 (2.9%) 15
Kenema	7 (15.2%) 227 ha	32 (69.6%) 525 ha	7 (15.2%) 123
Kono	34 (100%) 568 ha	0	0
Western Area	19 (48.7%) 191 ha	12 (30.8%) 375 ha	8 (20.5%) 242
Total number (% of total) and total area (ha)	**727 (69.4%) 23,588 ha**	**280 (26.7%) 4,895 ha**	**40 (3.8%) 1,736 ha**

Source: Rashid-Noah et al. 2009

Table 2. A summary of the categorization of inventoried IVSs in Sierra Leone.

Although the IVS knowledge base has expanded over the past two decades, more work is needed to inventory and characterize the remaining IVSs in Sierra Leone using standardized methodologies. The development of an IVS knowledge base has the potential to speed up the implementation of necessary interventions, such as planning IVS development and use. The availability of modern land-surveying technology means that inventorying IVSs can now be carried out faster and more efficiently than in the past.

The significance of IVS cultivation in Sierra Leone

In 1956, the GoSL's Department of Agriculture (DoA) listed the following policy objectives (GoSL 1956):

- "Ensure an adequate supply of essential foodstuffs for the people.
- Improve agricultural methods for producing food and export crops…so that the producer will get a better return for his labor and enjoy a higher standard of living.
- Conserve soil and to maintain and improve its fertility by the encouragement of optimum land use."

These policy objectives differed little from those adopted in 1932 (GoSL 1932) and have remained, among others, the objectives of MAFFS since Sierra Leone attained independence in 1961 (GoSL 1961 and 2009; Spencer et al. 2009). The broad and ambitious nature of the policy objectives required adequate policy instruments. The DoA believed that all three objectives could be achieved by adopting improved swamp cultivation methods in place of the upland rice farming techniques practiced by the vast majority of the country's farmers. The DoA argued that such measures would make Sierra Leone self-sufficient in the production of rice (the country's main staple), prevent underemployment in rural areas, eliminate seasonal hunger (a yearly occurrence because of insufficient harvests and consequently insufficient rice storage), and make it possible for Sierra Leone to export rice to other countries. These arguments and assumptions remain pertinent to present-day thinking (GoSL 2005).

Several schemes have thus been launched to promote swamp development. As previously mentioned, the Rokupr RRS was established in 1934 to develop and test improved swamp rice seed varieties, and revolving seed schemes were launched to distribute improved seed varieties and extend credit to farmers to facilitate seed adoption.

Since the country's independence, the GoSL's agricultural development policy has been focused on achieving rice self-sufficiency, among other objectives. The government has led direct interventions, such as mechanical rice cultivation in the riverine grasslands around Gbundapi and Torma Bum and in the *bolilands* of Bombali and Tonkolili districts. In addition, during the 1970s and 1980s external donors funded integrated agricultural/rural development projects covering over 80% of the country. In 1972, the Eastern Area Integrated Agricultural Development Project (IADP) was launched in Kenema to develop approximately 2430 ha of IVSs for rice cultivation in parts of Kenema, Kailahun and Pujehun districts. Two years later, in 1974, the Northern IADP was launched in Makeni, which aimed to develop 3239 ha of IVS rice in Bombali and Tonkolili districts.

The IADP approach to IVS development entailed the following measures:

- providing credit for labor, pesticides, fertilizers and improved high-yielding varieties of seed to smallholder farmers
- training project farmers in efficient production techniques
- providing and supervising inputs and extension services at all stages.

The IADP scheme had the potential to produce an average yield of rice per unit area that was three times higher than the yield achieved under traditional farming in adjacent areas. Additionally, some improved seed varieties provided added potential to produce a second yearly crop.

All of these interventions targeted smallholder farmers, who make up approximately 90% of the farming population. However, the results of the various interventions were generally disappointing, and the overall performance of the agricultural sector has been poor over the past two decades.

IVS use

IVS land preparation varies by region. In parts of the southern and eastern regions of Sierra Leone, IVSs with bushy vegetation are normally brushed (using matchetes) and burned, together with the adjacent upland farm areas, in March or April (Baggie et al. 1986). IVSs with grassy vegetation are brushed rather than burned, and the grasses are left to rot for 2–3 weeks. The debris is then gathered into piles on the side of the swamp. A few days before direct seeding, farmers prepare the ground with minimal tillage.

In the northern region, IVSs are first brushed and/or burned. Next, the clods of grass are turned over to bury the unburned grasses. This is followed by a second, shallower hoeing and working of the soil into a finer bed. Seedlings 4–6 weeks old are then transplanted into the flooded or partially flooded swamp. Most local farmers do not have access to agro-chemicals, and even when they are locally available, most farmers cannot afford them, so they rarely fertilize their crops or take measures to control against insects and disease. Plate 7 shows the beds prepared for vegetable crops, while Plate 8 shows a partially prepared IVS (with mounds) and Plates 9 and 10 depict farmers manually transplanting seedlings in a flooded IVS in July.

Plate 7. Beds constructed in an IVS for the second season planting of vegetable crops.

Plate 8. Farmers transplanting rice seedlings in an undeveloped IVS in July.

Plate 9. A farmer transplanting rice seedlings in an IVS in July.

Plate 10. Maize and other food crops grown in an IVS as a second crop after rice.

Efforts to promote intensive IVS cultivation

After 1945, the GoSL and various development partners made serious attempts to persuade farmers to adopt intensive swamp cultivation on the Southeast Asian pattern—building water control channels, leveling and bunding (building bunds, or pond dikes) in paddies and using nursery and transplanting techniques.

This type of cultivation has two advantages: (1) no fallow period is required and (2) it produces higher yields than the traditional techniques applied to upland farms and swamps. Developed IVSs typically yield 1700–2200 kg/ha per cycle, compared to yields of 800–1500 kg/ha for upland and "traditional" swamp farming. Increased use of Sierra Leone's abundant swamplands is therefore an attractive prospect for government and development agencies eager to increase marketable rice surpluses, especially considering rapid urban population growth. Increased IVS use can also help avert the ecological problems thought likely to arise from the continued shifting cultivation (moving from one area to another) of the upland that is so prevalent in the country.

Constraints in IVS production systems

Although IVS agro-ecology is highly productive, it is nevertheless associated with several agronomic and socioeconomic problems that adversely affect production. These problems are listed below.

Agronomy

- Iron toxicity in IVS water and soil (Hague 1977; Abu et al. 1987; RRS 1985) affects up to 60% of the total swamp area.
- Uncontrolled and prolonged flooding limits production in IVSs. Most swamps are periodically submerged in 30–60 cm of water for 2–6 months between June and November (the rainy season).
- Soils are generally acidic, with pH ranging from 3.5 to 5. This low pH inhibits nutrient elements such as phosphorus, zinc and calcium. Many of the IVSs in Sierra Leone have shallow and sandy subsoils. This causes considerable leaching, especially since some of these soils are kaolinitic (a mineral in clay soil containing an aluminum compound), with low organic matter and low cation exchange capacity.
- In traditional IVS rice farming systems, seedlings are transplanted from late July through September. In Sierra Leone, the period of transplanting coincides with the heaviest rainfall and flooding, causing limited growth and development of the transplanted rice.
- Pests and disease are serious problems in IVS production systems. However, there has been very little research about how to control them in the IVS agro-ecology.
- Very little or no fertilization occurs in traditional IVS production systems. The few farmers that do apply fertilizer do so at a relatively low rate, and it is usually broadcast into the floodwater about 2–3 weeks after transplanting. This means that any applied nutrients are not fully used, and in most cases plants suffer from nutrient deficiencies in later stages of growth.

Socioeconomics

- IVS development and cultivation is labor intensive, but rural areas of Sierra Leone are marked by widespread labor shortages because of youth migration to urban centers and other areas of economic opportunity (particularly mines) in search of often elusive job opportunities.
- In the IVS cropping systems, rice is grown as the sole crop. Many farmers prefer the uplands because they are conducive to crop diversification as a risk aversion strategy. In the upland, numerous subsidiary crops (including cassava, pepper, garden eggs [eggplant], cucumber and other local vegetables) are grown in addition to rice, thereby ensuring that farmers' households have food if the main rice crop fails.
- Dry season cropping, which forms an integral part of the IVS production system, continues to hold little attraction for most farmers. During the dry season, rural communities are often engaged in social activities (e.g. initiation of youth into secret societies) and other essential livelihood activities (e.g. house building/repairs, harvesting wild palm fruits for palm oil production), illicit diamond mining (especially in the southeastern and eastern regions) and gold mining in the northern region.
- Another obstacle to IVS cultivation is its association with human health hazards, especially malaria, schistosomiasis, onchocerciasis, pneumonia, bilharzia and elephantiasis (Dingle 1984).

Water, land and aquatic resources in Sierra Leone

The shoreline of Sierra Leone is approximately 560 km long and includes the estuaries of three large river networks (the Scarcies, Sierra Leone and Sherbro rivers) and four coastal islands. The continental shelf has an estimated area of 26,611 km^2 (EPA 2015). The country is rich with water resources. Inland water resources, such as rivers, lakes, IVSs and floodplains, support a large number of aquatic organisms. Wetlands, including IVSs, are particularly important assets for the rural poor (Turner et al. 2000). In addition to supporting agricultural production, these ecosystems supply local communities with hunting, fishing, forest and forage resources (Roberts 1988; Scoones 1991; Adams 1993) and serve as local hot spots for biodiversity (Chapman et al. 2001).

Rural communities use the water resources of IVSs to fulfill a variety of daily household needs. In addition to the water resources themselves, the biological diversity of IVSs is probably among the most important functions for the local communities since IVSs are important locations for collecting nonagricultural plant resources. Local communities have considerable knowledge of useful plant species, including the abundance of the plants, where they are located and how to use them (Rodenburg et al. 2012). Aquatic plants are rich in protein and minerals and have high nutritional value. Abundant species like duckweed, *Salvinia* spp., *Ipomea* spp. and other aquatic plants are highly nutritious but are not fully used at present, likely because of limited knowledge regarding their usefulness. These species could be studied, harnessed and cultivated on a large scale as subsidiary crops.

Aquaculture potential in Sierra Leone

Aquaculture in Sierra Leone is concentrated in the provinces in the south (primarily in Bo, with some activities located in Moyamba and Pujehun), the north (primarily in Tonkolili, with some activities in Bombali) and the east (Kailahun, Kenema and Kono). Aquaculture ponds were established in these locations because of the availability of suitable IVSs, which enable fish production throughout the year. These IVSs, which have clean and constantly flowing water and suitable soil and topography, have primarily been used by smallholder farmers to culture tilapia. Additionally, in recent years, farmers have begun to practice integrated aquaculture and agriculture (IAA). Culturing fish in earthen ponds is the most common system of fish culture in Sierra Leone. The principal species cultivated in these ponds is Nile tilapia (*Oreochromis niloticus*) (Linnaeus 1758), but research institutions, and occasionally development partners, have also introduced the culture of catfish species (*Clarias gariepinus* [Burchell 1822] and *Heterobranchus* sp.), recruiting the fish into ponds during flood inundation.

As reported in the Comprehensive Aquaculture Baseline Study: Sierra Leone report (COFREPECHE. 2013), a 2005 baseline survey of aquaculture in Sierra Leone found 1127 fishponds in the country. Of these, only 657 were in operation, while over 40% were abandoned. Dabo et al. (2009) reported 2593 fishponds in 12 districts and in Western Area, of which 2164 (83%) were in Tonkolili District. A recent WorldFish aquaculture assessment recorded 2087 fishponds in Tonkolili and Bombali districts alone, of which 98.6% were in Tonkolili (WorldFish personal

communication). Of the recorded number of fishponds in Tonkolili, about 84% belong to individuals or families (with 80% owned by men and 4% owned by village communities or farmers' associations). Men play an active role in the construction and management of fishponds, while the role of women becomes apparent at harvest time and women and children carry out the day-to-day maintenance of the ponds and farm. It is commonly believed that labor-intensive work, such as pond construction and bunding, can only be done by men, while menial jobs, such as harvesting fish and day-to-day farm affairs, are under the purview of women and children (ABCO 1992). However, the research team observed during this assessment that some women, particularly single mothers, own and maintain ponds alone, though they hire men to do the construction work.

An IVS in Tonkolili District.

In the riverine villages, consumption of freshwater fish provides the main source of animal protein. Other protein sources include hunted game and protein-rich plants. Villagers use scoop nets, fencing techniques, and traps to capture fish from surrounding water bodies, especially IVSs. Gill net fishing is practiced in larger rivers. According to the FAO TCP/SIL/2904 project, the estimates from the Agricultural Sector Review and the Agricultural Development Strategy, sustainable annual yield ranges from 16,000 to 40,000 t (FAO 2003). There is room to increase the annual production from aquaculture if adequate effort and attention are given to efficient management and sustainable development of these practices.

Plate 11. A valley section in Tonkolili District grown with rice.

Plate 12. A poorly developed pond in an IVS in Tonkolili District.

Plate 13. An abandoned fishpond in an IVS in Tonkolili District.

Constraints on aquaculture development in Sierra Leone

One major obstacle for aquaculture development in Sierra Leone is an overreliance on marine capture fisheries and the extensive network of rivers and lakes in the interior of the country. It is important to note that the poor development of IVSs in Sierra Leone is largely a result of a lack of capacity, which limits the fisheries subsector of the country's economy. The African Regional Aquaculture Review meeting (FAO 2000) identified a number of constraints affecting the development of the aquaculture sector in Africa, and these factors are relevant to the situation in Sierra Leone. The constraints on aquaculture development in the country include the following:

- poor aquaculture development policies
- the country's poor economic situation
- few fish farming traditions
- inappropriate technologies and approaches
- lack of genetically proven fish seed
- unavailability of quality and good growth enhancing fish feed
- prohibitive transportation costs and poor transportation infrastructure
- the existence of numerous nonfunctional government aquaculture stations
- weak extension services
- weak research institutions (including their impact)
- limited coordination between research and development sectors
- few reliable production situations
- inadequate information management systems.

Objectives

The objectives of the assessment were to address the following:

- Review current knowledge on the status and use of IVSs in Sierra Leone (including locations, typologies, social and economic values, interventions made and successes and constraints to development) and supporting policies.
- Provide technical assistance to WorldFish and its partners—Agricultural Cooperative Development International/Volunteers in Overseas Cooperative Assistance/Sustainable Nutrition and Agriculture Promotion (ACDI-VOCA/SNAP) and the Cooperative of American Relief Everywhere (CARE International)—on an IVS assessment in Tonkolili District. Specifically, the assessment should address the following:
  - inventory and mapping (via GPS coordinates) and classification (based on the methodology proposed in Annex I of the Terms of Reference [ToR]) of IVSs of the district
  - physical properties (e.g. catchment size and characteristics, swamp size in dry and wet seasons, soil quality,

inundation period and height)
    - water characteristics (e.g. seasonality of water availability, water management systems, and irrigation infrastructure)
    - socioeconomic aspects (e.g. dependent population, access to an IVS, land tenure, use constraints, and barriers to using a particular IVS).
    - agro-ecological productivity and cropping systems, such as description of crops, cropping patterns, productivity, economic outcomes, and crop uses (sales and consumption) for rice, vegetables and trees
    - fish systems (e.g. presence of wild fish, capture systems, presence of aquaculture, uses and productivity)
    - institutional and governance aspects
    - analysis of interventions made into IVSs, outcomes of the interventions and lessons learned.
- Identify potential options for IVS improvements for sustainable food production and income and income generation, with an emphasis on IAA systems, such as rice-fish, rice-fish-vegetables and vegetables-fish.
- Provide inputs for written reports that improve understanding of (a) current status, use and management of IVSs for food production, and (b) opportunities for diversification and improvements in the productivity of IVSs to enhance income and nutritional outcomes for dependent farming and fishing communities in Tonkolili District.

Vegetables produced in IVSs.

Study methodology

Preamble

This study used a mixed methods approach, employing both quantitative and qualitative data collection techniques to analyze (a) the social and economic aspects of IVSs, as well as current knowledge regarding their use, (b) the physical characteristics of IVSs and (c) prevailing knowledge of aquaculture in Sierra Leone. The following subsections present the technical approach and methodology used in the study. Section 2.2 describes the sample frame and sample size determination, section 2.3 outlines the data collection methodology and section 2.4 describes the data quality control measures implemented during the study.

Sample frame and sample size determination

The study was conducted in all 11 chiefdoms of Tonkolili District in Northern Province. A total of 600 questionnaires were administered. To select a sample for the study, the population of each of the 11 chiefdoms was calculated as a percentage of the total population of Tonkolili District. This step determined the weighting given to the chiefdoms during sample selection. For example, because the Gbonkolenken chiefdom contains 7.1% of the district's population, 7.1% of the 600 survey respondents were selected from that chiefdom.

Communities were randomly selected within each chiefdom, and the number of communities selected depended on the predetermined sample size for the chiefdom. For the selected communities, the research team created a complete listing of households using IVSs. The team used a random numbers table to select no more than 15 households per community. Table 3 presents the sample distribution for the study.

No.	Chiefdom	Population: number (% of district total)	Sample
1	Gbonkolenken	20,475 (7.1%)	43
2	Kal Simire	19,817 (6.9%)	41
3	Kalasongoia	10,480 (3.6%)	22
4	Kolifa Mabang	12,437 (4.3%)	26
5	Kolifa Rowala	47,371 (16.4%)	98
6	Konike Barina	13,411 (4.6%)	28
7	Konike	42,968 (15.0%)	90
8	Malal Mara	14,025 (4.9%)	29
9	Sambaya	22,728 (7.9%)	47
10	Tane	22,242 (7.7%)	46
11	Yoni	62,651 (21.7%)	130
District total		**288,625 (100%)**	**600**

Table 3. Sample distribution in Tonkolili District.

Data collection methodology

The study employed several data collection techniques.

Secondary data collection

As a prerequisite to begin the study, the research team reviewed relevant documentation (e.g. consultancy reports and government publications) to examine the socioeconomic aspects, physical and hydrological characteristics, and the status of fisheries and aquaculture of IVS use in Sierra Leone to (a) to learn what already exits and (b) determine the course the consultancy should pursue. The sources of this secondary data are referenced in the study report.

Primary data collection

Primary data collection in this study included the following:

- Key informant interviews (KIIs) were conducted at the beginning of the assessment to gather information about the main issues and contact persons relevant to the study. These interviews served as a prerequisite to inform the development of a questionnaire and interview guide to be used during FGDs (see below). Key informants included officials from the Ministry of Agriculture, MAFFS, the FAO office in Freetown and nongovernmental organizations (NGOs) engaged in IVS development in Sierra Leone.
- A structured questionnaire was administered to all 600 selected respondents in Tonkolili District and covered the following issues:
  - Socioeconomic aspects:
    - land tenure
    - access to land/IVSs by respondents (including women)
    - knowledge on status and use of IVSs
    - role of women in IVS use
    - previous interventions in IVS development
    - constraints on IVS development
    - agro-ecological productivity and cropping systems
    - crop uses.
  - Physical characteristics of IVSs:
    - area, topography and soils of IVSs
    - nature of the water regime
    - development status of swamps
    - nature of the catchment in which the IVS is located.
  - Aquaculture:
    - knowledge and practice of aquaculture
    - information on harvesting and selling fish
    - fish marketing
    - credit sources
    - fish farmers' perception of sustainable integrated agriculture-aquaculture
    - endemic freshwater fish species
    - food crops and aquatic plants from IVSs.

Direct measurement
Direct measurement was employed in two instances: (1) the size of IVSs (using GPS) and (2) chemical assessment of IVS water.

FGDs
Targeted male and female respondents (including youths) and community leaders were encouraged to reach a consensus on the various issues investigated in the questionnaire. The research team developed an interview guide to ensure the discussions were relevant to the issues crucial to the study (partly informed by the KIIs conducted prior to the FGDs). These issues included land tenure, current and potential uses of IVSs, constraints on IVS use, roles of women, knowledge of and attitudes to aquaculture, and envisaged uses of IVSs.

Validation meeting
Representatives of various stakeholder groups (including potential beneficiaries from Tonkolili District, relevant government ministries, partner NGOs, farmers, fish farmers and representatives from the local communities) were invited to a validation meeting in Magburaka, the headquarter town of Tonkolili District, where the IVS assessment report was presented with a view to eliciting their comments and suggestions for improving the document. Their inputs were incorporated into the final report.

Data quality control measures
A key consideration throughout the implementation of the survey was to ensure all collected data would be of high quality. The following measures contributed to this quality assurance process:

Field instruments
The draft questionnaire and interview guide for the FGDs were reviewed during, and finalized after, the training sessions for enumerators and field supervisors. This process helped ensure the following:

- The wording of the questions was concise, unambiguous and relevant to the objectives of the assignment.
- The questions were brief and direct, which helped ensure respondents remained interested and focused.

Training
A total of 32 enumerators were jointly provided by CARE, ACDI-VOCA/SNAP, and district personnel from the Ministry of Fisheries and Marine Resources (MFMR) and MAFFS. Of these enumerators, 24 (75%) were male and eight (25%) were female. The selection of enumerators was guided by the following considerations:

- the ability to communicate well in Temne, the predominant local language of the Tonkolili District, and Krio, the national lingua franca
- field experience in data collection, especially in rural communities
- familiarity with the geography and related logistical issues of the survey district.

Training was conducted by the consultants at Magburaka, the headquarter town of Tonkolili District. Field staff training was very thorough, requiring each trainee to review every question included in the questionnaire. All questions were translated into both Krio and Temne to ensure trainees fully understood the survey instruments and their roles. The training emphasized field methods, with a special focus on ethical conduct in data collection and management. During their training, trainees conducted mock interviews to enhance their familiarity with the instruments. The enumerators piloted the survey instruments in villages near the training center. This exercise informed subsequent improvements to the questionnaires.

A total of four supervisors (one each to cover three contiguous chiefdoms) were engaged to ensure all completed questionnaires were reviewed in the field with the enumerators for accuracy, consistency and completeness before being submitted for data entry and analysis.

Data compilation
The data was compiled from field recording sheets and entered into the database by WorldFish partners who were directly supervising the data collection in the field.

Data analysis
Analysis of the data was conducted using two different software packages: (1) SPSS, to analyze response data from the field surveys, and (2) ArcGIS 10.2.2, to map villages/towns and their associated IVSs. Two sets of maps were produced: (1) a map of Tonkolili District with chiefdom boundaries, and (2) individual chiefdom maps showing the location of towns/villages and associated IVSs that were accessed during the field surveys.

Limitations of the study
During data collection, there was a problem relating to the accuracy of reading the GPS information for a pair of chiefdoms. This problem was corrected by re-surveying the IVSs in the two chiefdoms. The new GPS coordinate data was entered in the original database, and the corrected coordinates were then plotted on the maps of the two chiefdoms.

SECTION A: SOCIOECONOMIC SURVEY

Characteristics of respondents

Gender

Males made up the majority of respondents (79.5%) for the survey (Table 4), and they dominated all of the chiefdoms overall. This is not surprising because households in Northern Province (indeed, in all rural areas of Sierra Leone) are traditionally headed by men. However, the loss of many men during the 1991–2002 civil war and the recent Ebola epidemic, as well as from the accelerated pace of migration of male youth to urban centers and other areas of economic opportunity, has meant that an unusually high number of households (20.5%) are now headed by women. This relatively substantial proportion of female-headed households underscores the importance of the contributions women are making to rural livelihood security, and of the urgent necessity to address women's needs in future agricultural and rural development undertakings.

Chiefdom	Gender	
	Male (% of total)	Female (% of total)
Tane	37 (82.2%)	8 (17.8%)
Kolifa Rowala	71 (73.2%)	26 (26.8%)
Gbonkolenken	35 (81.4%)	8 (18.6%)
Kolifa Mabang	21 (77.8%)	6 (22.2%)
Yoni	113 (87.6%)	16 (12.4%)
Konike Barina	98 (84.5%)	18 (15.5%)
Kalasogoia	17 (77.3%)	5 (22.7%)
Konike Sanda	2 (100.0%)	0 (0.0%)
Kafe Simira	23 (56.1%)	18 (43.9%)
Sambaia	38 (77.6%)	11 (22.4%)
Malal Mara	21 (75.0%)	7 (25.0%)
District total	**476 (79.5%)**	**123 (20.5%)**

Table 4. Gender of respondents.

Age distribution

The age distribution of the respondents ranged from 19 to over 65 years old (Table 5). Younger respondents were not selected because people up to 18 years old are classified as children and included in their parents' households. The majority of respondents (67.1%) were in the age clusters between 26 and 55 years old. Although the number of respondents in the 19–25 age bracket is modest, it is worth noting that in the past many people of this age would still have been farming with their parents and would not yet be heads of households. Young people have been forced to take on additional responsibilities and become household heads because of the drastically reduced number of older men, largely from the civil war and the recent Ebola epidemic.

Age	Frequency	% of total
19–25	42	7.0
26–35	123	20.5
36–45	176	29.4
46–55	103	17.2
56–65	93	15.5
Over 65	62	10.4

Table 5. Age distribution of respondents.

Education

The majority of the respondents (61.3%) have had no formal education, while 8.2% have only attended primary school and 6.3% have attended junior secondary school (Figure 3). Together, these three categories represent 75.8% of the total, underscoring the very low level of education in the district. The concentration of respondents within these educational categories is consistent in all chiefdoms of the survey.

A rather impressive percentage (12.7%) has had Quranic education. This is not surprising considering the importance of Islam in the district. Such scholars are usually religious leaders and feature prominently in local decision-making.

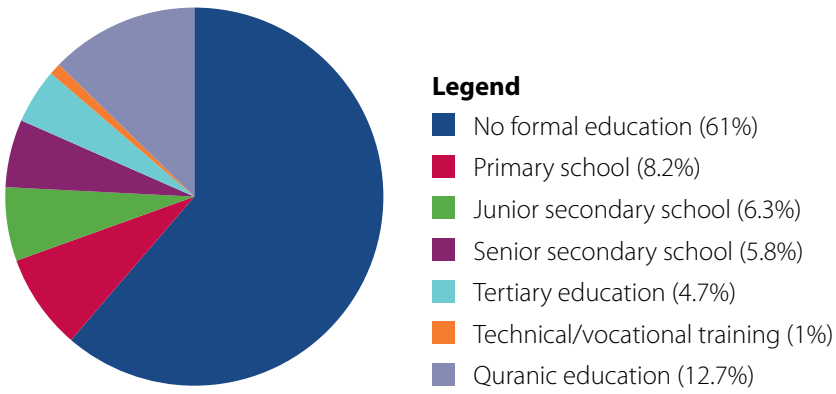


Figure 3. Education levels of respondents.

Marital status

The overwhelming majority of respondents (85.64%) were married, while only a handful (11.02%) were single (Figure 4). This is not surprising, since rural residents in Sierra Leone typically marry early; remaining unmarried is socially unacceptable, as it is believed to be the precursor to promiscuity. The data also reveals that separations are few (0.8%). Respondents explained that the incidence of widows and widowers was largely a consequence of the recent Ebola epidemic.

Children

Overall, the number of children per household is high (Figure 5). The majority (77.4%) of respondents have four or more children: 32.9% have four to six children, while 44.5% have seven or more.

Household members were asked in FGDs to share the reasons why they tended to have large families. Their responses are summarized below:

Infant and under-five mortality in their communities (indeed, in much of the country) are among the highest in the world. In Sierra Leone, the infant mortality and under-five mortality rates are 87.1 per 1000 and 120.4 per 1000 live births, respectively (World Bank 2015). These high rates are largely a result of very poor health services, though the introduction of free medical services for pregnant women, breastfeeding mothers and children under 5 years of age has improved the situation to some extent. Consequently, women tend to have as many children as possible because they do not know how many will survive. Table 6 presents national data relating to the total fertility rate (per woman) and mortality rates for infants and children under 5.

Indicator	Measurement
Crude birth rate	35.6 per 1,000 (2015)
Crude death rate	13.03 per 1,000 (2015)
Infant mortality rate	87.1 per 1,000 (2015)
Under-five mortality rate	120.4 per 1,000 (2015)
Life expectancy at birth	51.4 years (2015)
Total fertility rate	4.6 per woman (2010)
Contraceptive prevalence rate	15.6% of women aged 15–49 years (2013)

Source: World Bank 2015

Table 6. Selected demographic and other health indicators.

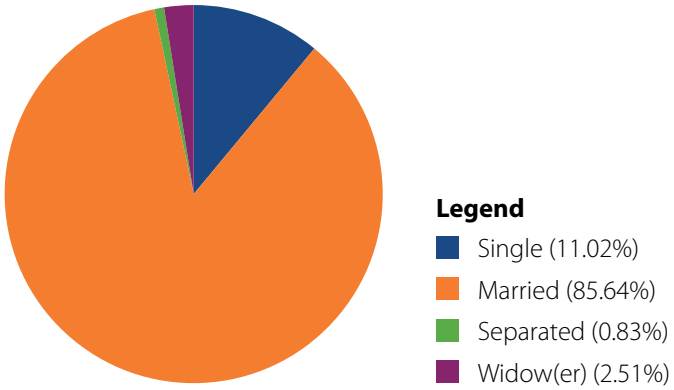


Figure 4. Marital status of respondents.

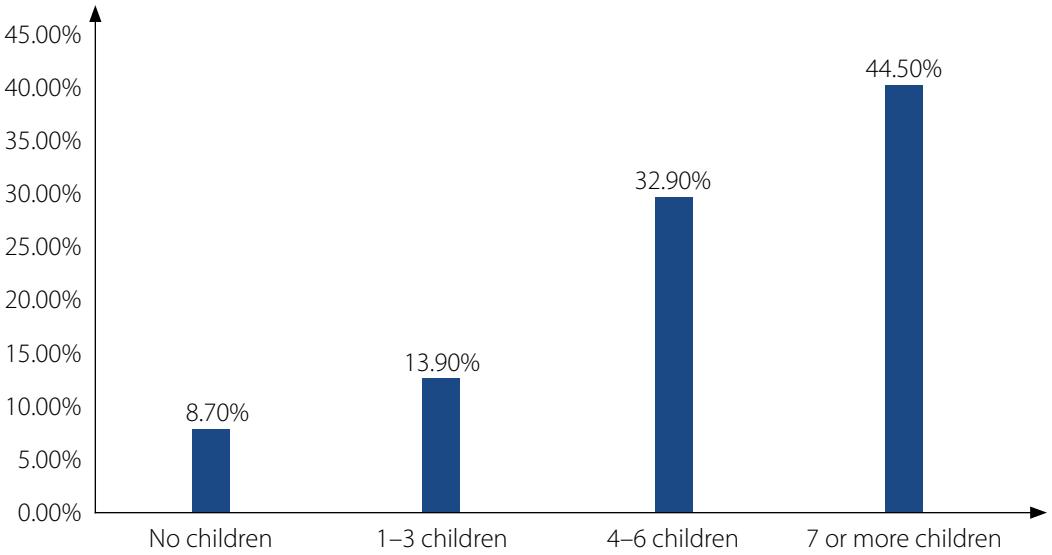


Figure 5. Number of children per household.

- Rural areas of Tonkolili District are predominantly poor farming communities where the production of rice on the upland under the rotational bush fallow system (see below) and in IVSs are the main systems of cultivation. Farming is labor intensive because very little farm machinery is available to the average farmer. In such an economy, children are assets because they contribute to the farm's labor force, so it is rational economic behavior to have many children. It is significant that when asked to define poverty, most respondents cited "childlessness" as a key parameter in their definitions.
- In the study area, many families tended to view childbearing as a gamble: the more children one has, the higher the chances of producing a child who will become affluent enough to be the family "savior." In support of this belief, they state that they know poor people like themselves who have produced wealthy and influential members of society.
- Very low contraceptive use is another factor in accounting for high fertility. According to the 2005 Poverty Reduction Strategy Paper, the national contraceptive prevalence rate was 4% for 1995–2001.
- The high number of children per household is also a result of polygamy, which is prevalent in Tonkolili District.

Main economic activities

Respondents engaged in various economic activities (Figure 6). Farming (91%) is by far the most important economic activity, followed by petty trading (3.7%) and teaching (3.3%). Other minor economic activities include health work and various civil service engagements.

Economic activities of communities in Tonkolili District can be divided into two subcategories: (1) agricultural and (2) nonagricultural.

1. **Agricultural activities**. These refer to subsistence farming of such staple food crops as rice, cassava, yams, sweet potatoes and a variety of local fruits and vegetables. The predominant farming method is the rotational bush fallow system, in which one piece of land is cultivated for some years and then left for some years to restore the fertility of soil naturally. In this method, a plot (usually a well-developed secondary bush[1] that has laid fallow for 6 years or more) is selected, cleared and sown to grow rice and a variety of other crops. Rice is also cultivated in IVSs, which produce higher yields than the upland, but which are unattractive to local farmers because of their high labor demand (for water control and transplanting), and because rice cultivation in IVSs is practiced as a monoculture.

   Women traditionally produce vegetables solely for household consumption. However, because of increasing needs for cash, women are now cultivating crops such as cassava, yams, sweet potatoes, pineapples and a wide variety of vegetables specifically for the market.

2. **Nonagricultural activities**. The main nonagricultural activity is petty trading, which is dominated by women. Traders sell both locally produced and imported foodstuffs and other consumer goods (e.g. clothing, petroleum products, beverages). Men's involvement tends to be limited to nonfood items. The percentage given for petty trading should be treated with caution: the 3.7% stated here probably refers to those solely dependent on trade, but it should be noted that many households engage in trade (especially with food items) if surpluses are available after satisfying household requirements. Some households sell farm produce to satisfy urgent social needs, such as festivities, even at the expense of household subsistence needs.

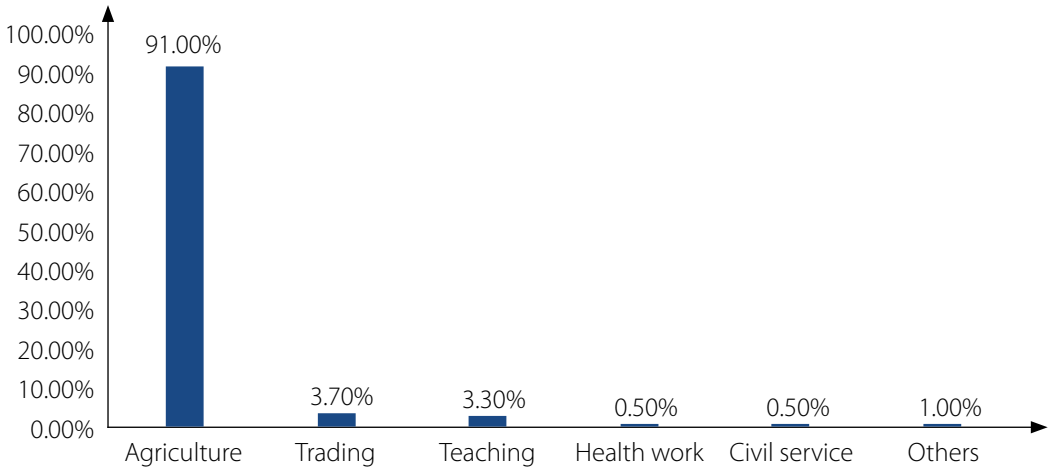


Figure 6. Main economic activities of the respondents.

The main problem encountered in petty trading relates to traders' limited access to the funds necessary to start their ventures. The usual recourse has been to borrow seed money from moneylenders or local merchants, which is repaid at exorbitant rates of interest. High interest rates, combined with the fact that loan units are typically small, keep most involvement by women in trading restricted to a small scale.

Other nonagricultural activities include teaching, health work and various civil service engagements, all of which account for only a small proportion of respondents. The vast majority of these formal sector employees are not indigenous to Tonkolili District, do not own swamps and are typically not engaged in agricultural pursuits.

Estimated annual household incomes

The overwhelming majority of households have very low annual incomes (Figure 7): 46.4% have incomes below SLL 1,000,000 (less than USD 200), while 42.4% have incomes between SLL 1,000,001 and SLL 5,000,000 (USD 200–1000). Combined, a staggering 88.8% have annual incomes (including remittances from friends and relatives) below SLL 5,000,000 (USD 1000). Only 11.2% of all households have annual incomes in excess of SLL 5,000,000.

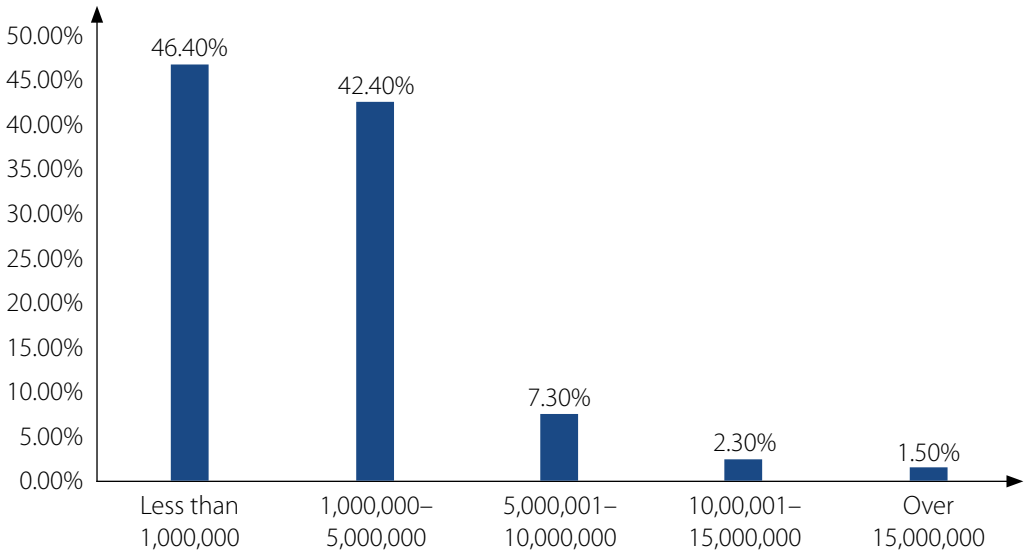
These findings are not surprising, given that most respondents are subsistence-oriented. The situation has recently been exacerbated by the migration of young men away from their communities in search of economic opportunities and by the recent Ebola epidemic, both of which further eroded the productive capacities of the communities.

Land tenure and access to land for agriculture

Prevailing land tenure system

To understand land laws in the provincial areas of Sierra Leone, it is necessary to remember that individual property does not exist. In the rural areas of Tonkolili District, land is always owned by the extended family and never exclusively by an individual (Renner-Thomas 2010). This highlights the need for externally assisted farming systems improvement interventions to be based on households' ownership against community group ownership.

All adult men belonging to an extended family have equal rights as one another, and no member may be deprived of the use of family land. Access to land is influenced by gender and marital status. All male family members have inalienable rights to family land that can never be revoked. Female family members have unrestricted access to family land as long as they remain unmarried. Although women have access to family land for farming, preference is always given to men because they have the responsibility to provide for their households. Unmarried women, on the other hand, belong to their fathers' households, and their food and other needs are provided by their parents. When a woman marries, her right to her father's family land is revoked, as she now becomes a member of another family—her husband's—and her direct access to land for her farming needs is now restricted to the land of her husband's extended family.



Note: exchange rate at time of survey: USD 1 = SLL 5000.

Figure 7. Estimated annual household income of respondents.

Nearly all the respondents (97.2%) claim that women have access to land for all of their farming needs in Tonkolili (Table 7). The overwhelming majority of respondents in all chiefdoms of the district endorse this claim.

Chiefdom	Number of women with access to land for farming under customary tenure laws (% of total)	
	YES	NO
Tane	43 (95.6%)	2 (4.4%)
Kolifa Rowala	94 (96.9%)	3 (3.1%)
Gbonkolenken	39 (90.7%)	4 (9.3%)
Kolifa Mabang	27 (100.0%)	0 (0.0%)
Yoni	123 (95.3%)	6 (4.7%)
Konike Barina	116 (100.0%)	0 (0.0%)
Kalasogoia	21 (95.5%)	1 (4.5%)
Konike Sanda	2 (100.0%)	0 (0.0%)
Kafe Simira	41 (100.0%)	0 (0.0%)
Sambaia	49 (100.0%)	0 (0.0%)
Malal Mara	27 (96.4%)	1 (3.6%)
District total	**582 (97.2%)**	**17 (2.8%)**

Table 7. Women's access to land for their needs.

Land rights apparently originated with the first cultivation. The area controlled by each extended family is commensurate with the area of virgin forest cleared by the family's ancestors. Family land boundaries are more or less fixed today since there are no more virgin forests to be cleared.

Under the communal tenure system, the head of the extended family—usually the oldest male member—protects and allocates land to members for their various needs. In the case of a land dispute (when another family claims a portion of the family land), the head of the extended family—who is usually the most knowledgeable in such matters—acts as spokesman for the family when the matter is taken before the paramount chief for arbitration. Because the head of the extended family is the oldest member and therefore is usually the most experienced farmer, he also decides which areas have not been laid fallow for a long enough period (and which, therefore, may not be cultivated) and those that can be cultivated. When the head of the extended family dies, headship is passed on to the eldest surviving brother, or to the eldest son of the deceased.

Although communal ownership is the prevailing land tenure system in the Tonkolili District, additional rights to particular parcels of land for individual members are recognized under the following circumstances:

- If a member habitually cultivates a particular IVS, over the years the swamp tends to be reserved for that member's use as long as there is no land shortage.
- If a member plants trees with economic value (such as palm oil, coffee, cashew, oranges or mangoes) he has undisputed right to the use of that land for as long as those crops occupy it. Family members who establish fishponds also have similar security of tenure. The land, however, never becomes private property.

The position of strangers

For the purpose of this study, a "stranger" is defined as an outsider—someone who has no consanguineal relationship with the extended family (i.e. is not related by blood). Locally, a stranger is defined as "somebody from far away." A stranger never ceases to be a stranger in Tonkolili District, regardless of the length of stay. Strangers may obtain land for farming by "begging" from the heads of their host families. This usually involves payment of a small annual royalty, known locally as *bora*. *Bora* is not rent, per se, paid to the landowners for the use of their land. Rather, it is perceived as a token symbolic gesture in recognition of the fact that the land user does not own it. This practice is intended to forestall future claims to the land. Usually, *bora* is paid in specified amounts of produce obtained from the land cultivated by the stranger. Increasingly, however, it is paid in cash.

Security of tenure

As previously stated, family members cannot be denied access to family land for their basic farming needs, even by heads of extended families. However, permanent use of land is only allowed if other family members are not likely to be adversely affected (i.e. the usage of the land will not create a land shortage). Additionally, when a family member habitually cultivates a swamp, plants tree crops or establishes fishponds, that person has an undisputed right to the land.

The same security of tenure applies to strangers. Strangers are only allowed to cultivate tree crops if members of the landowning family have abundant land to meet their various needs. In the case of a stranger who has been allowed to cultivate tree crops, the following rules apply:

- Under native law, the stranger cannot be evicted.
- The stranger's heirs are granted ownership of the crops when the stranger dies.
- Ownership of the land and crops revert to the host family if the stranger dies without leaving heirs.
- If the stranger decides to leave the host community for good, all rights to the tree crops must be sold to the landowners.

The existing land tenure system does not favor the leasing of substantial acreages of land for commercial farming, especially by outside entrepreneurs. In its bid to promote external investments, the central government has in recent years been instrumental in facilitating such leases in various parts of the country. This has usually resulted in tensions arising between the entrepreneurs and the host communities.

In recent decades, strangers' security of tenure of IVSs has been undermined. In 1974, the Northern Area Integrated Agricultural Development Project was launched with the aim of developing IVSs for rice cultivation in Bombali and Tonkolili districts. The project assisted farmers with extension services related to IVS development and cultivation, and it provided loans to enable farmers to acquire improved high-yield seeds and other farm inputs. Project-assisted farmers could now produce two crops of rice per year, which would substantially increase their income. FGDs revealed that this led several landowning families to take over cultivation of IVS plots that strangers had previously been allowed to use.

The three fundamental principles of communal land tenure can be summarized as follows:

- In all circumstances, the land belongs to the community and cannot be taken away from it without its permission.
- Within the community, all persons have the right to an area corresponding to their various needs.
- No one shall remain without land.

Attitudes toward land reform

The laws governing customary land tenure in the provincial areas of Sierra Leone have been subjected to critical scrutiny in recent decades (Green 1966; Moyo and Foray 2009; Renner-Thomas 2010). Specifically, the laws are deemed anachronistic and not secure enough to enable farmers to use their land as collateral for credit, which is essential for agricultural development. The 1974/75–1978/79 National Development Plan for Sierra Leone succinctly outlined the viewpoints emerging during that time: "The replacement of communal tenure by individual tenure may be an essential prerequisite if the standard of living of the community is to be improved. Certain forms of communal tenure may not provide security of tenure" (GoSL 1974).

In this study, respondents' attitudes toward land reform were explored during FGDs and KIIs. Key informants included the district officer (the highest-ranking government official at the district level) and select local leaders. The survey revealed general satisfaction with the prevailing land tenure arrangements. Virtually all landowning families are in favor of maintaining the status quo. This position is apparently encouraged by the fact that land is generally in abundant supply, as no land shortages were reported. Only strangers and prominent members of the respective communities—most of whom reside in the district and chiefdom headquarter towns and are engaged in business—are in favor of land reform to make freehold[2] property possible. This shows that this group of people is interested in large-scale land acquisition for plantation agriculture.

Farming ecologies in various communities

The three main farming ecologies in Tonkolili District are the upland, IVSs and *bolilands*. Farmers were requested to indicate which ecology or combination of ecologies they could access in their respective communities (Table 8). The upland/IVS combination is the most common, with 64.6% of respondents having access to it. Access to this combination of ecologies ranges from 37% in Kolifa Mabang to 84.4% in Tane and 100% in

Chiefdom	Percentage of respondents with access to various combinations of farming ecologies in Tonkolili District							
	Boliland only	Upland only	IVS only	Boliland/ upland	Boliland/ IVS	Upland/ boliland	Upland/ IVS	Boliland/ IVS/ upland
Tane	2.2	8.9	-	-	-	2.2	84.4	2.2
Kolifa Rowala	1.0	-	3.1	-	9.3	2.1	56.7	27.8
Gbonkolenken	4.7	2.3	-	-	-	2.3	79.1	11.6
Kolifa Mabang	-	3.7	3.7	3.7	22.2	-	37.0	29.6
Yoni	5.4	-	8.5	0.8	19.4	-	58.9	7.0
Konike Barina	1.7	3.4	2.6	-	-	-	79.3	12.9
Kalasogoia	4.5	-	-	-	-	-	81.8	13.6
Konike Sanda	-	-	-	-	-	-	100.0	-
Kafe Simira	2.4		2.4	-	-	-	41.5	53.7
Sambaia	-	-	-	-	-	-	67.3	32.7
Malal Mara	10.7	-	14.3	-	10.7	-	42.9	21.4
District total	**3.0**	**1.7**	**3.8**	**0.3**	**7.2**	**0.7**	**64.6**	**18.7**

Table 8. Farming ecologies in various communities.

Konike Sanda. The second-most common combination of ecologies is *boliland*/IVS/upland (18.7%).

Access to land for various farming needs

Availability of land for the various farming needs of households does not appear to be problematic in any of the chiefdoms in Tonkolili District. Overall, 96.5% of respondents have adequate access to land for all their farming needs (Table 9). Adequate access to land for all farming needs ranges from 89.3% in Malal Mara to 100% in Kolifa Mabang, Konike Sanda and Sambaia.

Chiefdom	Percentage of respondents with access to land for their various farming needs	
	Yes	No
Tane	95.6	4.4
Kolifa Rowala	96.9	3.1
Gbonkolenken	93.0	7.0
Kolifa Mabang	100.0	0.0
Yoni	96.1	3.9
Konike Barina	98.3	1.7
Kalasogoia	90.9	9.1
Konike Sanda	100.0	0.0
Kafe Simira	97.6	2.4
Sambaia	100.0	0.0
Malal Mara	89.3	10.7
District total	**96.5**	**3.5**

Table 9. Respondents' access to land for various farming needs.

Land acquisition for farming

The main methods of acquiring land for farming are as follows (Figure 8):

1. Family ownership: Most farmers (83.1%) obtain plots from their extended family landholdings. This land is usually given as a right and without difficulty.
2. Usage rights granted by landowning families are the second-most common means of acquiring land for farming (12.5%). This is the method by which strangers or nonfamily members acquire land. In this arrangement, the farmer does not pay rent per se, but is required to give a token proportion of the harvest to the landowning family as *bora*. This practice is designed to forestall future claims to land by the user.
3. A small number of respondents (2.7%) acquire land through leasing. Land is usually leased when a substantial acreage is required for commercial (i.e. tree crop) farming.
4. An even small number of respondents (1.7%) claimed that they acquired land through purchase. Since freeholding is practiced only in Western Area and is virtually unknown in the surveyed district, this claim was further probed through KIIs. Money had indeed changed hands, but the transactions were long-term leases of land for palm oil cultivation, so these respondents should instead be subsumed under the land lease category.

Access to and use of IVSs

IVSs are ubiquitous, and the overwhelming majority (97%) of respondents have access to IVSs in their respective communities (Table 10). As with all other family lands, the allocation of IVSs for farming is controlled by the head of the extended family, whom all family members recognize as the custodian of family assets. Because he is usually the oldest family member, the head is also the most experienced farmer and is therefore able to assess the land requirements of family members based on need.

The survey did not encounter any evidence of particular swamps that members are not allowed to use. However, the head of the extended family sometimes places restrictions on fishing in particular swamps for specified periods. The lifting of such fishing bans is also the prerogative of the family head. This practice is intended to prevent overfishing of the swamps and allow the fish to replenish, which indicate that the communities have knowledge of fishstock conservation in IVSs.

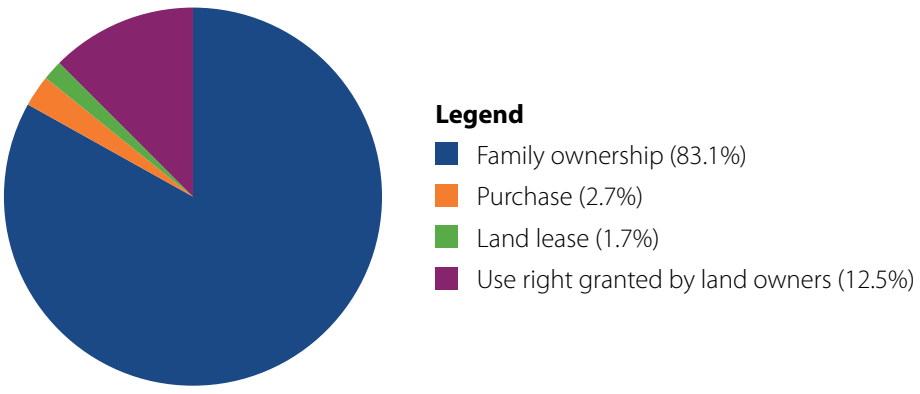


Figure 8. Land acquisition for farming in Tonkolili District.

Chiefdom	Percentage of respondents with access to IVSs	
	Yes	No
Tane	93.3	6.7
Kolifa Rowala	96.9	3.1
Gbonkolenken	97.7	2.3
Kolifa Mabang	96.3	3.7
Yoni	94.6	5.4
Konike Barina	99.1	0.9
Kalasogoia	100.0	0.0
Konike Sanda	100.0	0.0
Kafe Simira	100.0	0.0
Sambaia	98.0	2.0
Malal Mara	96.4	3.6
District total	**97.0**	**3.0**

Table 10. Respondents' access to IVSs.

Most IVSs in Tonkolili District are undeveloped, meaning that they are rain-fed and have no water control structures in place. Rice cultivation in such swamps is confined to the rainy season and only produces one crop. Survey data reveals that nearly half (49.6%) of the respondents cultivate IVSs only during the rainy season. Rice production in IVSs is typically monoculture. Communities on or near vehicle roads and can easily sell crops (e.g. cassava, sweet potatoes and local vegetables) and cultivate these crops during the dry season in their IVS plots after the harvest of the rice crop. Such communities (accounting for 45.9% of respondents) therefore cultivate their IVS in one form or another year-round. Only 4.2% of respondents reported cultivating their IVS only during the dry season. Respondents in this category are typically female household heads, who do not have access to male labor to cultivate rice and whose livelihoods are dependent on the production and sale of tubers like cassava and sweet potatoes as well as local vegetables.

Data shows that less than a quarter of respondents (24.5%) have access to developed IVS plots (Table 11). An IVS is considered developed if it has been leveled, with all tree stumps removed and has water control structures such as drainage channels and bunds.

Field observations and FGDs revealed, however, that most of the so-called "developed" swamps are only partially developed. Typically, these IVSs have main drainage channels, but have not been fully de-stumped or leveled. The IVS plots of the vast majority of respondents (75.5%) are undeveloped.

Chiefdom	Percentage of respondents with developed IVSs	
	Yes	No
Tane	22.0	78.0
Kolifa Rowala	5.4	94.6
Gbonkolenken	52.4	47.6
Kolifa Mabang	8.7	91.3
Yoni	10.7	89.3
Konike Barina	50.4	49.6
Kalasogoia	0.0	100.0
Konike Sanda	0.0	100.0
Kafe Simira	0.0	100.0
Sambaia	49.0	51.0
Malal Mara	25.0	75.0
District total	**24.5**	**75.5**

Table 11. Respondents with developed IVSs.

Only 274 respondents (45.7%) reported that they had received some form of assistance for IVS development. FGDs revealed that much of this assistance dates back to the 1970s and 1980s, when the Northern IADP promoted IVS development for rice cultivation in the Bombali and Tonkolili districts. In recent years, assistance for IVS development has largely been limited to infrequent and irregular visits by extension workers from MAFFS. This extension service is ineffective for two reasons: (1) there are too few agricultural extension personnel, many of whom are poorly trained, and (2) logistical provision is poor, because most personnel are not mobile and do not have necessary supplies, such as rain gear, and are therefore ill motivated. For these reasons, contact with farmers is few and far between. In fact, more than half of the respondents (54.3%) have yet to receive assistance from any external agency for IVS development. These respondents continue to utilize their swamps using traditional methods.

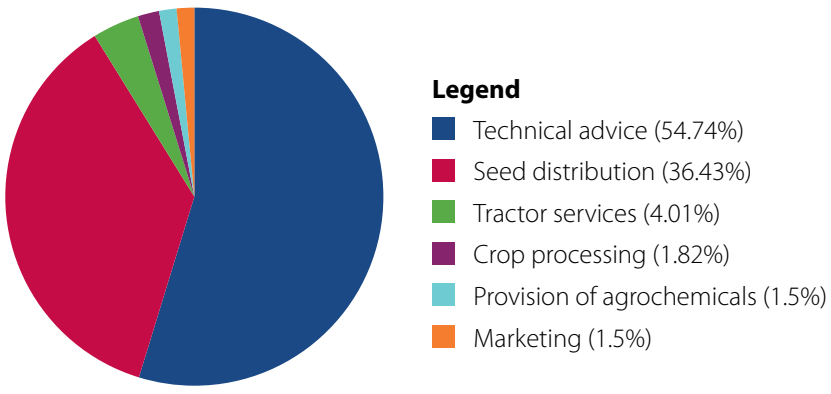


Figure 9. Extension services provided by MAFFS.

The services provided by MAFFS extension personnel for IVS development have tended to concentrate on the distribution of improved seeds (36.4%) and technical advice regarding cultural practices (54.7%) (Figure 9). Farmers' financial needs (e.g. undertaking the construction of water control structures, hiring required additional labor and paying for other required inputs) remain unaddressed.

Farmers' perceived main constraints on IVS development and use

According to farmers, there are significant constraints on IVS development and use in Tonkolili District (Figure 10). The most pressing constraint relates to the high labor requirement (cited by 55.3% of respondents). This is significant because several farming communities continue to lose farm labor through the migration of youth to urban centers and other areas of economic opportunity. The second-most recognized constraint by the respondents was the high financial cost related to the construction of water control structures. Other constraints include the distance of IVS plots from communities, health hazards associated with IVS cultivation and the lack of mixed cropping, which enable farmers to cultivate additional crops along with the main rice crop.

High labor requirements and the high cost of water control structures are the main deterrents to IVS use in virtually all chiefdoms in Tonkolili District (Table 12), and there are differences among chiefdoms regarding their perception of the various constraints.

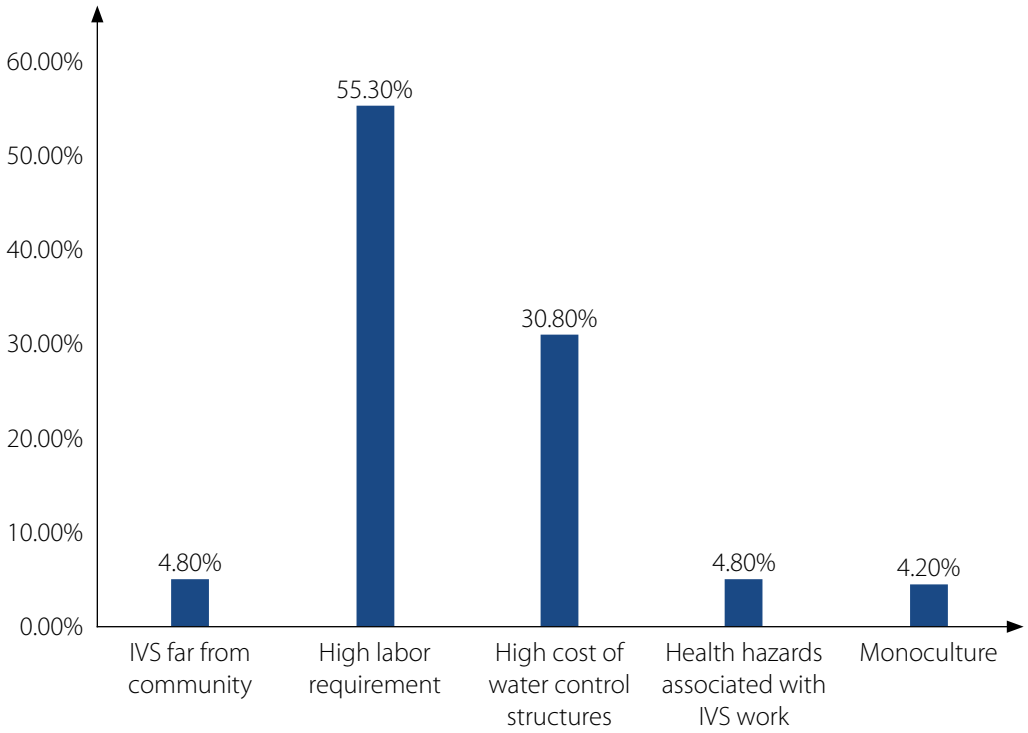


Figure 10. Farmers' perceived constraints on IVS development and use.

Chiefdom	Perceived main constraints on IVS development: number (% of total)					Number of respondents
	Far from settlement	High labor requirement	High cost of water control structures	Health issues	Mono culture	
Tane	2 (6.3%)	25 (78.1%)	3 (9.4%)	1 (3.1%)	1 (3.1%)	32
Kolifa Rowala	1 (1.8%)	37 (66.1%)	8 (14.3%)	5 (8.9%)	5 (8.9%)	56
Gbonkolenken	1 (2.6%)	21 (53.8%)	13 (33.3%)	1 (2.6%)	3 (7.7%)	39
Kolifa Mabang	2 (11.8%)	13 (76.4%)	2 (11.8%)	-	-	17
Yoni	4 (9.3%)	14 (32.5%)	22 (51.2%)	1 (2.3%)	2 (4.6%)	43
Konike Barina	3 (3.9%)	42 (41.2%)	45 (44.1%)	8 (7.8%)	3 (2.9%)	102
Kalasogoia	-	1 (100.0%)	-	-	-	1
Konike Sanda	-	1 (100.0%)	-	-	-	1
Kafe Simira	-	-	1 (100.0%)	-	-	1
Sambaia	-	25 (89.3%)	3 (10.7%)	-	-	28
Malal Mara	2 (18.2%)	4 (36.4%)	4 (45.4%)	-	-	11
District total	**16 (4.8%)**	**183 (55.3%)**	**102 (30.8%)**	**16 (4.8%)**	**14 (4.2%)**	**331**

Note: Only respondents who either had developed swamps or were interested in IVS development offered their opinions.

Table 12. Farmers' perceived constraints on IVS development and use, by chiefdom.

Access to essential infrastructure

Access to markets

A large majority of farmers (78.3%) said they had access to a market for their farm produce, while only 21.7% claimed having none. Of the 469 respondents with access, 33.3% went to daily local markets, 36.5% to periodic (*lumo*) markets and 20.2% to urban markets, including Tonkolili and other district headquarter towns, as well as Freetown, the national capital.

Farmers groups

Nearly half of respondents (49.2%) belonged to various forms of farmers groups in the chiefdoms of Tonkolili District (Table 13). This allows for further interventions for an external agent to motivate farmers groups to step into value chain interventions such as input supplies as an agribusiness. One example is fish and vegetable seed supply. Membership in such groups ranged from as low as 14.3% in Sambaia Chiefdom to as high as 78% in Kafe Simira Chiefdom.

Chiefdom	Respondents who are members of farmers groups: number (% of total)	
	Yes	No
Tane	24 (53.3%)	21 (46.7%)
Kolifa Rowala	23 (23.7%)	74 (76.3%)
Gbonkolenken	26 (60.5%)	17 (39.5%)
Kolifa Mabang	14 (51.9%)	13 (48.1%)
Yoni	69 (53.9%)	60 (46.5%)
Konike Barina	68 (58.6%)	48 (41.4%)
Kalasogoia	18 (81.8%)	4 (18.2%)
Konike Sanda	1 (50.0%)	1 (50.0%)
Kafe Simira	32 (78.0%)	9 (22.0%)
Sambaia	7 (14.3%)	42 (85.7%)
Malal Mara	13 (46.4%)	15 (53.6%)
District total	**295 (49.2%)**	**304 (50.8%)**

Table 13. Membership in farmers groups among respondents.

Figure 11 presents the types of farmers groups, categorized here by the range of services they provide (vertical axis) and the accruing percentages of farmers groups that fall within each category (horizontal axis).

Among the range of services provided by farmers groups (Figure 11), the most common are crop processing only (27.5%), procurement of farm inputs (24.1%), savings and credit (16.3%), procurement of inputs and crop processing (10.5%) and marketing (8.1%).

Food production systems

Crop cultivation

Most households in Tonkolili District are engaged in subsistence farming of such staple food crops as rice, cassava, yams, sweet potatoes, maize, millet and a variety of local fruits and vegetables.

The majority of farmers cultivate the upland, where the predominant farming method is the rotational bush fallow system (see section 3.1.6). After a year of cultivation, a new farming site is selected and the previous year's plot is left to lie fallow. This system of cultivation has come under severe criticism in recent years for several reasons: (a) its yield is considered low and deemed unsound in the face of increasing food demands, especially to feed the nonfarming population, and (b) it degrades the environment through deforestation and soil erosion. Farmers, on the other hand, are attracted to this system because it enables them to produce all the crops they require on one plot, thereby minimizing the use of scarce labor.

Rice is also cultivated in IVSs, which produce higher yields than the upland but are unattractive to local farmers because of the high labor demand (to control water and transplant crops), and because

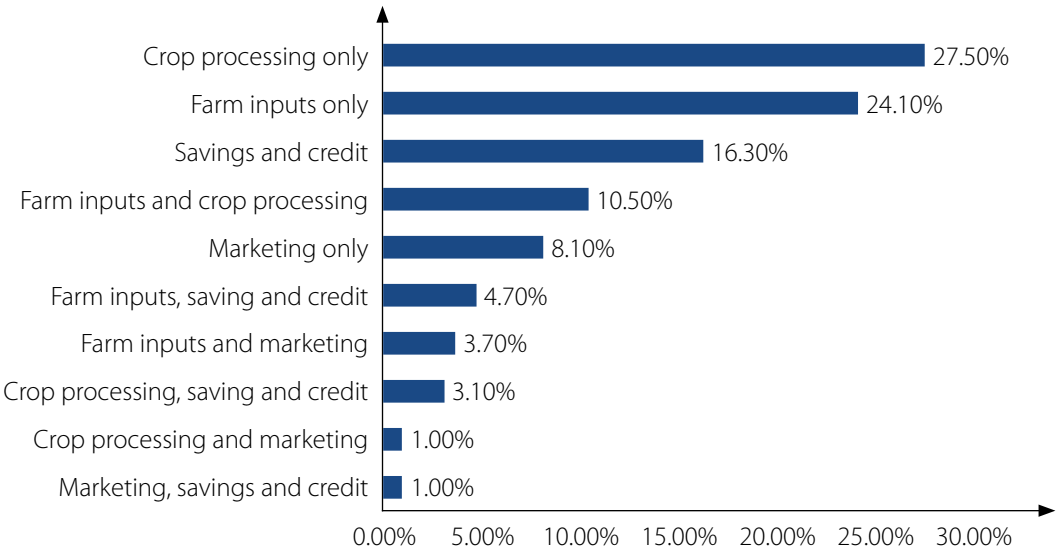


Figure 11. Services provided by various farmers groups.

they are monoculture. *Bolilands* are increasingly being cultivated because substantial acreages can be brought under cultivation using tractors for plowing and harrowing. However, their key disadvantage is low soil fertility.

Men are actively involved in both upland farming (using the rotational bush fallow system) and IVS cultivation, performing labor intensive activities, such as brushing, felling, land clearing and plowing fields. Women are usually integral members of the household labor force. Their tasks include weeding, scaring away birds and harvesting. Female-headed households are usually hard pressed for labor to undertake the typically "male" tasks and must often incur loans to hire external labor.

Women also traditionally produce vegetables for household consumption. However, in reaction to increasing cash needs (prompted by the massive devaluation of the Leone in the past 10 years, from USD 1=SLL 3000 in 2006 to USD 1=SLL 6000 in 2016) and the resulting increases in the prices of essential commodities and services, women are now cultivating crops specifically for the market. Typical "cash crops" in this regard include cassava, yams, sweet potatoes, pineapples and a wide variety of vegetables. The location of communities on or near main motor routes has encouraged women to produce for the market.

Economics of crop production

This section is based on farmer recall data, which always has the potential of being under- or overestimated depending on the accuracy of respondents' memories as well as their perception of the purpose of the exercise. For example, when an investigation is known to be the precursor to launching an agricultural development project, there is a tendency for respondents to overemphasize their problems and understate their advantages and resources to encourage the external agents and program designers to devote more resources. Enumerators were trained to ask probing questions to minimize such tendencies.

It can be observed from the analysis that only one tree crop, oil palm, is featured. Tree crop cultivation is relatively new in the district. A few farmers have palm oil plantations, but the majority of farmers depend on wild oil palm for their palm oil needs. Other tree crops, such as mangos, oranges, guava, bananas and others, are also grown, but on a very small scale. Usually farmers do not cultivate a farm per se, but instead have a small number of these trees on the periphery of their settlements.

Regarding food crops, IVS-cultivated rice, cassava, Chinese yam and sorghum are included in the analysis. The vast majority of other food crops—maize, millet, pepper, garden eggs, beniseed (sesame), okra, pumpkin, cucumber and a host of local vegetables—have not been addressed individually, as they are normally intercropped with rice on the upland farm.

Farm sizes

Farm units are typically small, which is consistent with the subsistence-oriented nature of farming in Tonkolili District. The majority of farms, ranging from 51.4% for upland rice to 90.6% for cassava, are under 1 ha in area (Table 14). The percentage of farms in other size categories progressively decreases as farm sizes increase.

Production costs per hectare

The inputs taken into consideration to estimate production costs include seed/planting material and hired labor. No costs have been inputed for family labor or for land. The production costs per hectare for the various crops (Table 15) show that agricultural production is of low cost in the communities included in the study. The majority of farmers for the various crops spend less than SLL 300,000/ha.

Value of harvest per hectare

Dependence on low-input traditional production methods results in low yields. Respondents' estimates of the value of their harvests (Table 16) reveal low harvest values for all crops. Overall, nearly a quarter of all respondents (24.4%) estimated the value of their harvests at below SLL 400,000. This was most common among cassava farmers (50.8%) and least common among IVS rice farmers (6.1%). A further 39.7% reported harvest values between SLL 400,001 and 800,000, with 53.8% of upland rice farmers fitting into this bracket, contrasted with only 19.6% of oil palm famers.

Sufficiency of production for subsistence requirements of households

The majority of respondents considered the harvests of most of their crops to be sufficient for the subsistence requirements of their households (Table 17). However, anecdotal evidence indicates that almost all rural households experience food shortage between July and September every year. During this "hungry season," as it is called, food stocks are typically depleted. One reason for this is the poor postharvest practices (including inefficient processing techniques and crop loss in storage because of barn pests), which can account for as much as 30% of grain loss. Other often overlooked causes of food shortage include (a)

Crop	Farm sizes (ha)				Number of respondents
	<1 ha	1 to <2 ha	2 to <3 ha	= or >3 ha	
Oil palm	105 (52.8%)	64 (32.1%)	26 (13.1%)	4 (2.0%)	199
Upland rice	235 (51.4%)	148 (32.3%)	50 (10.9%)	24 (5.3%)	457
IVS rice	178 (56.9%)	89 (28.4%)	37 (11.8%)	9 (2.9%)	313
Cassava	107 (90.6%)	9 (7.6%)	2 (1.7%)	0 (0.0%)	118
Chinese yam	207 (80.6%)	41 (15.9%)	6 (2.3%)	3 (1.2%)	257
Sorghum	208 (80.3%)	42 (16.2%)	5 (1.9%)	4 (1.5%)	259
Mean % of all crops	**68.8%**	**22.1%**	**7.0%**	**2.2%**	**-**

Note: Depending largely on labor availability, respondents typically cultivate a number of these crops simultaneously.

Table 14. Farm sizes among respondents.

Crop	Production costs/ha (SLL)					Number of respondents
	< 300,000	300,001–500,000	500,001–700,000	700,001–900,000	Over 900,000	
Oil palm	93 (46.8%)	51 (25.6%)	24 (12.1%)	31 (15.6%)	10 (5.0%)	199
Upland rice	282 (61.7%)	94 (20.6%)	21 (4.6%)	34 (7.4%)	26 (5.7%)	457
IVS rice	170 (54.1%)	60 (19.2%)	23 (7.3%)	46 (14.7%)	14 (4.5%)	313
Cassava	102 (86.5%)	13 (11.0%)	1 (0.8%)	2 (1.7%)	0(0.0%)	118
Chinese yam	142 (55.3%)	82 (31.9%)	20 (7.8%)	10 (3.9%)	3 (1.2%)	257
Sorghum	190 (73.3%)	44 (17.0%)	11 (4.2%)	11 (4.2%)	3 (1.2%)	259
Mean % of all crops	**63.0%**	**20.9%**	**6.1%**	**7.9%**	**2.9%**	**-**

Table 15. Production costs of respondents.

Crop	Value of harvest per hectare: number of respondents per category (% of total)			Number of respondents
	<SLL 400,000	SLL 400,001–800,000	SLL 800,000+	
Oil palm	45 (22.6%)	39 (19.6%)	115 (57.8%)	199
Upland rice	53 (11.6%)	246 (53.8%)	158 (34.6%)	457
IVS rice	19 (6.1%)	154 (49.2%)	140 (44.7%)	313
Cassava	60 (50.8%)	45 (38.1%)	13 (11.0%)	118
Chinese yam	49 (19.0%)	95 (37.0%)	113 (44.0%)	257
Sorghum	95 (36.7%)	105 (40.5%)	59 (22.8%)	259
Mean %	**24.4%**	**39.7%**	**35.9%**	**-**

Table 16. Value of harvest per hectares for respondents.

Crop	Sufficiency of crop production for household needs: number of respondents per category (% of total)		
	SUFFICIENT for household needs	INSUFFICIENT for household needs	Number of respondents
Oil palm	135 (67.8%)	64 (32.2%)	199
Upland rice	263 (57.5%)	194 (42.5%)	457
IVS rice	195 (62.3%)	118 (37.7%	313
Cassava	80 (67.8%)	38 (32.2%)	118
Chinese yam	127 (49.4%)	130 (50.6%)	257
Sorghum	209 (80.7%)	50 (19.3%)	259
Mean %	**64.3%**	**35.7%**	**-**

Table 17. Sufficiency of crop production for household needs.

Crop	Proportion of harvest consumed: number of respondents per category (% of total)				Number of respondents
	Below 40%	41%–60%	61%–80%	81%–100%	
Oil palm	114 (57.3%)	64 (32.2%)	12 (6.0%)	9 (4.5%)	199
Upland rice	29 (6.3%)	50 (10.9%)	340 (74.4%)	38 (8.3%)	457
IVS rice	50 (16.0%)	44 (14.0%)	174 (55.6%)	45 (14.4%)	313
Cassava	73 (61.9%)	45 (31.1%)	-	-	118
Chinese yam	190 (73.9%)	57 (22.2%)	10 (3.9%)	-	257
Sorghum	117 (45.2%)	96 (37.1%)	36 (13.9%)	10 (3.9%)	259
Mean %	**43.4%**	**24.6%**	**25.6%**	**5.2%**	**-**

Table 18. Proportion of harvest consumed by respondents.

the sale of food to meet urgent social needs, such as payment of school charges, medical bills and clothing for household members, and (b) the lavish use of food for traditional ceremonies, such as child naming, initiation into secret societies, marriages and funerals.

Proportion of harvest consumed

The proportions of the various crops consumed by respondents are summarized in Table 18. As a result of low consumption of the crops primarily cultivated for sale, oil palm, cassava, Chinese yam and sorghum fall into the below 40% and 41%–60% categories. On the other hand, crops grown for household use (upland rice and IVS rice) show high proportions of consumption in the 61%–80% and 81%–100% categories.

Proportion of harvest sold

Table 19 presents the proportions of various crops sold. For those crops cultivated for sale (oil palm, cassava, Chinese yam and sorghum), few respondents fall into the below 40% category, but many more fall into the 41%–60% and 61%–80% brackets. This shows that the majority of farmers who grow these crops sell high proportions of their harvest. On the other hand, crops grown for household subsistence (upland rice and IVS rice) show high percentages of respondents in the below 40% category, but substantially lower percentages under the categories denoting higher proportions of crops sold.

Livestock ownership

Regarding livestock ownership in Tonkolili District (Figure 12), the most common form of livestock owned is the combination of small ruminants and poultry (48.2%), while the second-most common type is poultry only (20.5%). It is significant that nearly a fifth of respondents (19%) do not own any livestock at all.

Small ruminants and poultry (chickens and ducks) are the livestock of preference in all chiefdoms of Tonkolili District (Table 20), mainly because small ruminants (particularly goats and sheep) and local chickens require hardly any care since they roam and fend for themselves. Chickens are a convenient source of animal protein when entertaining guests, while goats and sheep feature prominently in various social events and traditional ceremonies.

In several communities, livestock, especially goats and sheep, are regarded as "banks." Banking facilities are few and far between, and many nonliterate community members do not trust banks as custodians of their scarce financial resources. A common practice, therefore, is to "save" by buying livestock, which can be sold when cash is required. Offspring of the animals are considered to be "interest" on their savings. Very poor farmers typically do not own ruminants because they cannot afford them. The wives and children of very poor farmers usually raise chickens and ducks for household

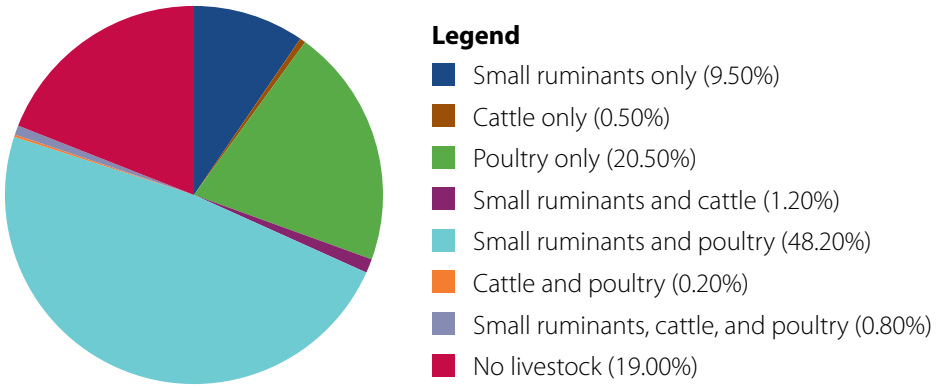


Figure 12. Types and combinations of livestock owned by respondents.

Crop	Proportion of harvest sold: number of respondents per category (% of total)				Number of respondents
	Below 40%	41%–60%	61%–80%	81%–100%	
Oil palm	47 (23.6%)	45 (22.6%)	100 (50.3%)	7 (3.5%)	199
Upland rice	311 (68.1%)	128 (28.0%)	18 (3.9%)	-	457
IVS rice	140 (44.7%)	126 (40.3%)	47 (15.0%)	-	313
Cassava	20 (16.9%)	59 (50.0%)	35 (29.7%)	4 (3.4%)	118
Chinese yam	55 (21.4%)	96 (37.3%)	105 (40.9%)	1 (0.4%)	257
Sorghum	56 (21.6%)	80 (30.9%)	112 (43.2%)	9 (3.5%)	259
Mean %	**32.7%**	**34.9%**	**30.5%**	**1.8%**	**-**

Table 19. Proportion of harvest sold by respondents.

needs and, when necessary, for sale. Unmarried poor farmers typically do not have any livestock.

Integrated agricultural systems practiced

The survey collected data about the integrated agricultural systems practiced in Tonkolili District (Figure 13). The highest proportion of respondents (40.1%) integrated crop farming with livestock rearing, while the next highest proportion (34.6%) practiced integration of wet season rice cultivation with dry season vegetable production. A significant percentage (14.2%) did not integrate rice farming with any other productive activity in IVSs. The integration of fish farming into local production systems has yet to become common practice in the communities included in the study.

Roles of women in IVS use

Crop farming

In IVS cultivation, women are integral members of the farm labor force in their households. Whereas men are traditionally responsible for land clearing and pest control (specifically, constructing peripheral fences to keep out rodents), women assist men by nursing and transplanting rice crops and are wholly responsible for weeding, harvesting and postharvest practices, including threshing and processing using mortar and pestle.

Female household heads may cultivate their own IVS plots, with the aid of hired labor, to meet household food requirements and address various social and financial responsibilities. Additionally, elderly wives in polygamous households often cultivate their own IVS plots after their children are grown in order to meet cash needs that their husbands may not be willing or able to address.

Traditionally, women cultivate vegetables for household consumption, typically in their backyards. In response to increasing cash needs, from the deterioration of currency exchange rates and the resulting massive price increases of essential commodities and services, women are now cultivating crops specifically for the market. Most of these enterprising women cultivate a range of crops (e.g.

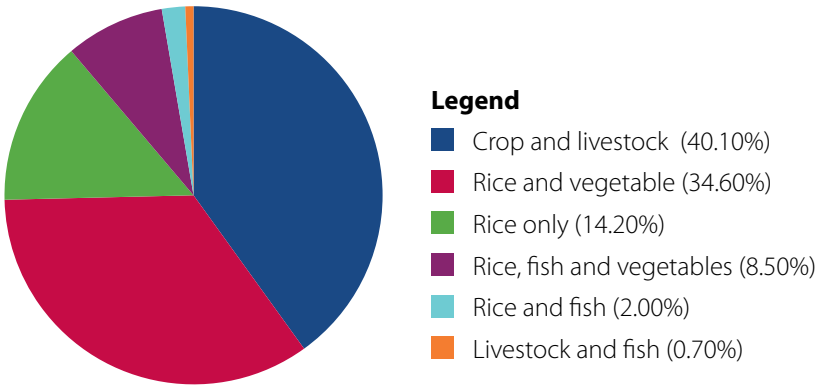


Figure 13. Integrated agricultural systems practiced in Tonkolili District.

Chiefdom	Types of livestock owned (frequencies and accruing percentages)							
	Small ruminants	Cattle only	Poultry only	Small ruminants and cattle	Small ruminants and poultry	Cattle and poultry	Ruminants, cattle and poultry	None
Tane	6 (13.3%)	1 (2.2%)	6 (13.3%)	1 (2.2%)	23 (51.1%)	-	-	8 (17.8%)
Kolifa Rowala	11 (11.3%)	-	22 (22.7%)	1 (1.0%)	41 (42.3%)	-	1 (1.0%)	21 (21.6%)
Gbonkolenken	3 (7.0%)	-	9 (20.9%)	-	22 (51.2%)	-	1 (2.3%)	8 (18.6%)
Kolifa Mabang	1 (3.7%)	-	4 (14.8%)	-	18 (66.7%)	-	-	4 (14.8%)
Yoni	10 (7.8%)	-	28 (21.7%)	2 (1.6%)	60 (46.5%)	1 (0.8%)	-	20 (21.7%)
Konike Barina	8 (6.9%)	-	28 (24.1%)	2 (1.7%)	56 (48.3%)	-	1 (0.9%)	21 (18.1%)
Kalasogoia	3 (13.6%)	-	6 (27.3%)	-	11 (50.0%)	1 (4.5%)	-	1 (4.5%)
Konike Sanda	-	-	-	-	2 (100.0%)	-	-	-
Kafe Simira	7 (17.1%)	-	8 (19.5%)	1 (2.4%)	18 (43.9%)	1 (2.4%)	-	6 (14.6%)
Sambaia	6 (12.2%)	-	8 (16.3%)	-	22 (44.9%)	-	2 (4.1%)	11 (22.4%)
Malal Mara	2 (7.11%)	-	4 (14.3%)	-	16 (57.1%)	-	-	6 (21.4%)
District total	**57 (9.5%)**	**1 (0.2%)**	**123 (20.5%)**	**7 (1.2%)**	**289 (48.2%)**	**3 (0.5%)**	**5 (0.8%)**	**114 (19.0%)**

Table 20. Types of livestock owned by respondents.

cassava, sweet potato and a wide variety of local vegetables) in IVS plots after the harvest of the rice crop. During the dry season, women in communities near urban centers or arterial motor roads now use IVS plots to grow exotic vegetables (e.g. cabbage, lettuce, radish and watermelon) that can be sold in the market.

Capture fisheries

Fishing in rivers or IVSs is a typical activity for women during the dry season, not only in Tonkolili District but in all provincial areas of Sierra Leone. Fishing is intended to (a) address household protein needs and (b) serve as a source of income, if the size of the catch is sufficient. Fishing in IVSs is an almost wholly female affair, since women are responsible for preparing fishing nets, fishing, fish processing and selling any surplus fish, if the catch is substantial. In all communities of the district, capture fisheries are used almost exclusively for household consumption, so only small quantities of fish (10%–20%) enter the local market. As mentioned earlier, the head of the extended family sometimes bans fishing in particular swamps for specified periods to prevent overfishing and allow the fish to replenish. Issues related to capture fisheries and aquaculture are discussed in more detail in Section C (Aquaculture).

Aquaculture

Women do not own fishponds in any of the communities sampled in the survey. The few ponds observed in Yoni Chiefdom were owned by men's groups, and the participation of women in aquaculture was limited to assisting the men with feeding, harvesting, processing and selling fish. FGDs with women revealed that they were interested in fish culture both to satisfy household protein needs and to earn incomes.

Assistance that women require to benefit from IVS interventions

The analysis so far has revealed that women's use of IVSs either for crop production or aquaculture is constrained by a number of factors, particularly the following:

- lack of available labor, which is required for IVS development work (e.g. construction of drainage control structures for rice cultivation or construction of ponds for fish culture)
- lack of capital and/or access to credit and loans necessary to buy inputs for farming (e.g. tools, seed, agro-chemicals and processing equipment) or aquaculture (e.g. tools for construction work, fingerlings and feed). Many rural credit organizations are more likely to lend to women than to men because women are generally more likely to repay loans.

Discussions with women indicate that the following interventions are urgently required if women are to benefit from IVS activities:

- Although there is acceptance in all chiefdoms of the district that women are permitted to access land for their various needs, many women caution that there is a tendency for men to take over development initiatives when they are seen as beneficial. For this reason, there should be a documented agreement with landowning families stating that women or women's groups who undertake development of an IVS plot, either for crop cultivation or for aquaculture, will have inalienable rights to it.
- Women should be organized into production groups for the provision of extension services and farm inputs. A word of caution is required here: Groups thrive in rural communities because they are cohesive. Groups formed by outsiders, however, are unlikely to have such cohesion because of a lack of knowledge regarding which factors unify and sustain them. It is advisable, therefore, to work with existing groups rather than externally creating new ones.
- Women typically do not have the required labor or capital for IVS development, so it is advisable to provide seed money to facilitate initial development work. Access to credit should be facilitated by linking women's production groups with reliable credit sources, such as community banks (CBs) and financial services associations (FSAs), which have been established in several chiefdoms of Tonkolili District.
- Women's production groups should be assisted in marketing their produce to their best advantage, because successful marketing will encourage them to sustain their engagement in IVS use.

SECTION B: PHYSICAL CHARACTERISTICS OF IVSs

Preamble

This section presents the findings of the physical characteristics of IVSs and discusses the implications of these characteristics with respect to the main objectives of the study. Summaries of the analyzed data for the entire district are presented in the main body of the report, while the breakdown of the data by chiefdom is presented in Appendix A. The categorization of the inventoried IVSs is summarized in Appendix B.

Mapped IVSs

Approximately 612 ha (1530 acres) of IVSs were accessed in all 11 chiefdoms of Tonkolili District. The size of individual swamps ranged from 0.4 ha

Figure 14. Chiefdoms of surveyed IVSs in Tonkolili District.

(less than 1 acre) to more than 3.2 ha (8 acres). The accompanying map (Figure 14) shows the distribution of the IVSs surveyed in every chiefdom. The distribution of the swamps within each chiefdom is presented in the individual chiefdom maps in Appendix C.

Physical characteristics of IVSs

Physical characteristics are key factors in selecting IVSs for interventions. These characteristics include accessibility, size, topography, soil type, rooting depth and water regime.

Accessibility

As shown in Figure 15.

Surface area of IVSs

The surface areas of swamps have been categorized according to size and frequency (Figure 16). Appendix A presents a breakdown by chiefdom.

Over half (51.4%) of the swamps accessed in the study range in area from 1 to 3 acres, while over 87% of IVSs have surface areas ranging from less than 1 to 4 acres (Figure 16). The total area of the IVSs accessed amounts to about 612 ha (1530 acres). Data obtained from the Agricultural Engineering Division (AED) of MAFFS shows the total area of IVSs in Tonkolili District to be 546.465 km^2 or about 54,647 ha (Appendix B), confirming that not all IVSs in the district were accessed and mapped in this study.

Topography

Topography is an important characteristic in IVS development because of its effect on the placement of structures for water control, leveling of plots and water management at the plot level. About three-quarters of IVSs surveyed have a flat topography (Figure 17), which may hinder drainage ability and so pose problems for building drainable aquaculture ponds. Appendix B presents a breakdown of the responses by chiefdom.

IVS soil types

For district-wide results for IVS soil texture (Figure 18), over 60% of swamps have loam soils, while 20.5%

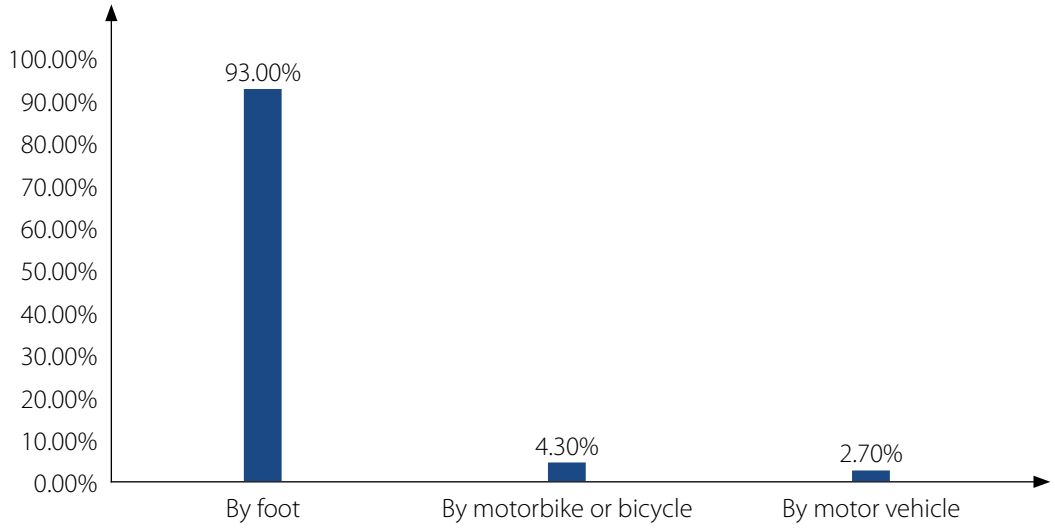


Figure 15. Ways of reaching the surveyed IVSs.

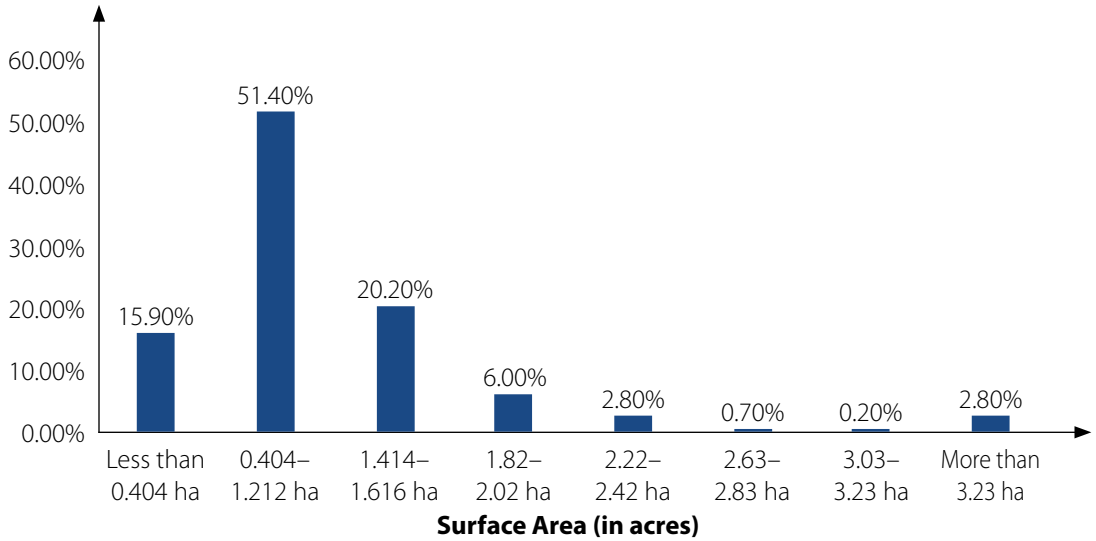


Figure 16. Distribution of the surface areas of the IVSs.

have clay soils. The promotion of water-harvesting technologies requiring the construction of earth dams means clay will be an increasingly important material, because it is used to build the cores of the dams to minimize water seepage.

Table 21 shows the grouping of chiefdoms and IVSs into loam and clay categories based on the predominance of soil textures important for crop production (i.e. loam soil) and the construction of water retention and/or control structures (i.e. clay soil), such as bunds, canals, drains and fishponds. Stability in the face of intense storms and floods is crucial to the longevity of these control structures. The soil textures included in the survey questionnaire were loam, clay and sand. Only three out of the 11 chiefdoms have predominantly clay soils, ranging from 34.1% to 45.56% of the total number of IVSs surveyed in the chiefdom. IVSs in eight chiefdoms have predominantly loam soils, ranging from 50% to 100% of the total number of IVSs surveyed in the chiefdom.

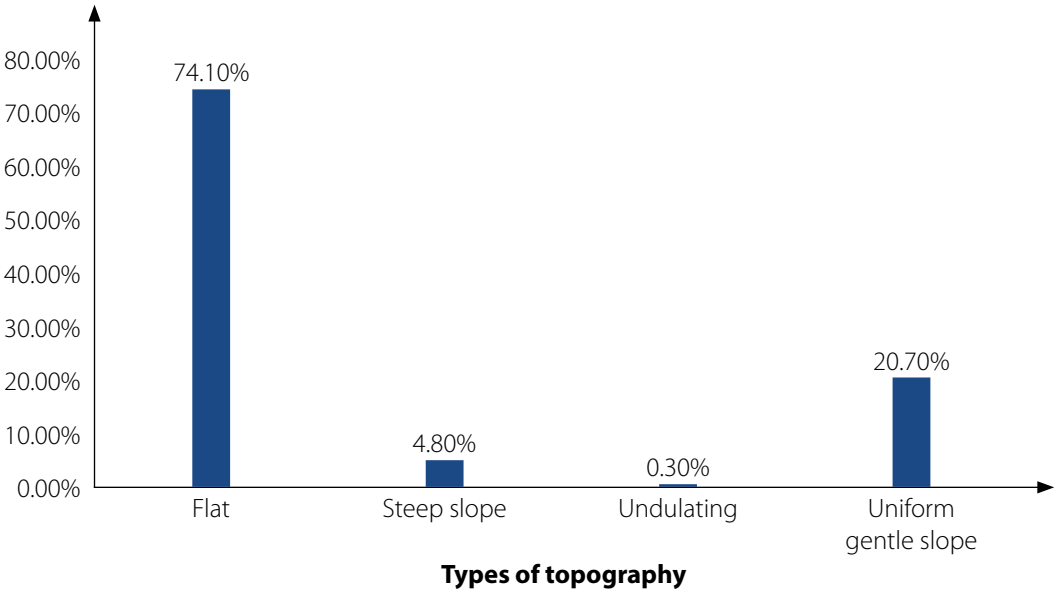


Figure 17. Types of topography in IVSs.

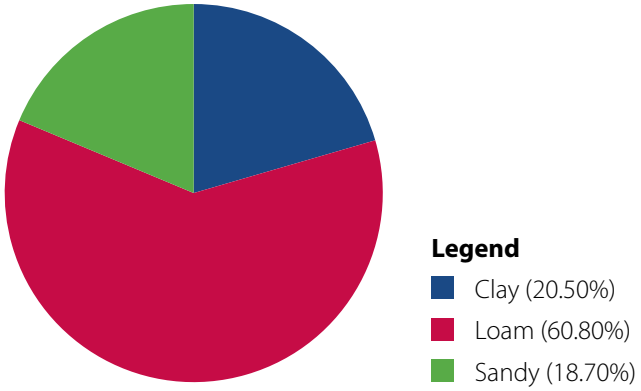


Figure 18. Distribution of IVS soils by texture.

Chiefdoms containing IVSs with mainly clay soil	IVSs with mainly clay soil	Chiefdoms containing IVSs mainly with loam soil	IVSs with mainly loam soil
Gbonkolenken	15 (34.1%)	Kafe Simira	37 (90.2%)
Kunike	41 (45.6%)	Kalansogoia	22(100.0%)
Tane	20 (43.5%)	Kholifa Rowala	63 (63.6%)
		Kholifa Mabang	13 (52.0%)
		Kunike Barina	14 (50.0%)
		Malal Marah	27 (96.4%)
		Sambaia	42 (89.4%)
		Yoni	91 (70.5%)

Note: Percentage of the total IVSs surveyed in the respective chiefdoms is given in parentheses.

Table 21. Categorization of chiefdoms by predominant soil texture.

IVS soil depth

The rooting depth of crops is an important first consideration when selecting a particular IVS for production, particularly for rice. Generally, a minimum rooting depth of 20 cm is considered adequate. Nearly one-third (29.5%) of IVSs have soils with inadequate rooting depth, which can be a serious constraint to rice production (Figure 19). Over half (54.4%) of the IVS soils sampled have depths ranging from 11 to 20 cm.

IVS water sources

Figure 20 and Table 22 present the results of the responses obtained for IVS water sources. Over 70% of IVSs are sourced by a stream. However, in terms of breakdown by chiefdom, Sambaia has the highest percentage of stream sources (94.7%), while Kalansogoia has the highest percentage of spring sources (72.7%) and Kunike Barina has the second-highest (64.3%). These chiefdoms may be good candidates for sustainable crop and fish culture, based on the water regime.

Water regime in swamps

The length of time a swamp has surface water present is an important factor for any type of food production intervention. For rice, this factor determines the number of crops that can be grown per year. Figure 21 and Table 23 present the results obtained on this characteristic, broken down by district and chiefdom, respectively. Table 30 shows that most swamps are seasonal (72.1%), and it is worth noting that high percentages of perennial swamps tend to be found in the northeastern part of the district, such as Kafe Simira (41.5%), Kalansogoia (36.4%), Kunike Barina (39.3%) and Sambaia (81.4%). This may be a result of the generally hilly terrain in these chiefdoms, with streams or spring sources being constantly fed from waters in the hilly catchment areas. However, the water regimes in these swamps will need to be verified during the peak period of the dry season (March/April).

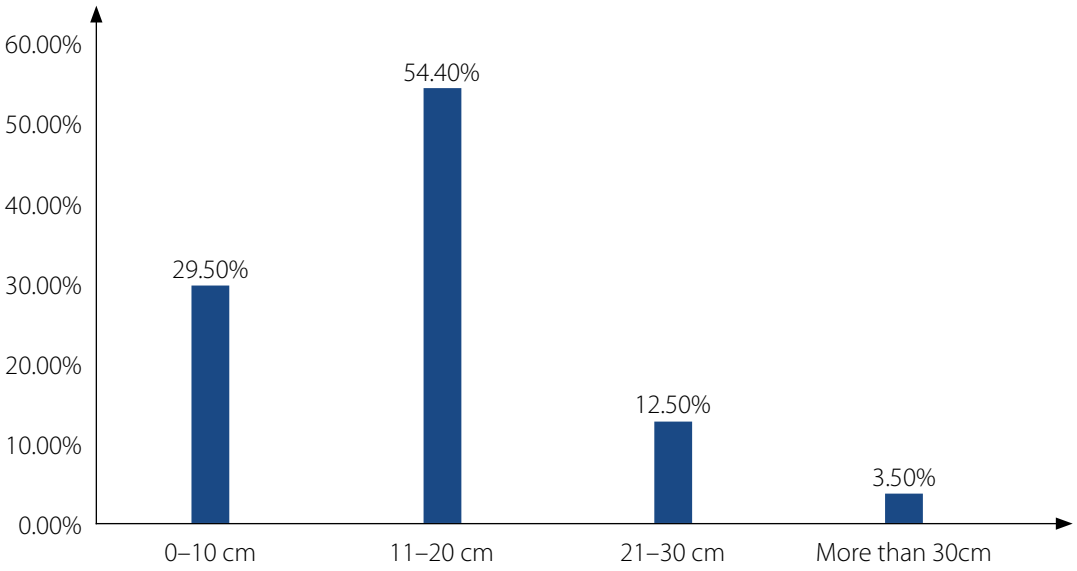


Figure 19. Distribution of soil depth in the IVSs.

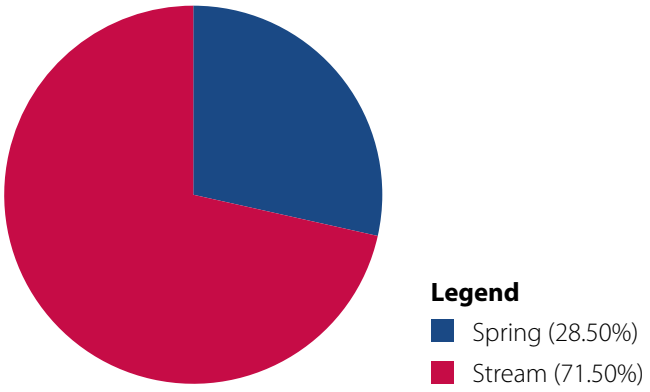


Figure 20. Distribution of water sources in IVSs.

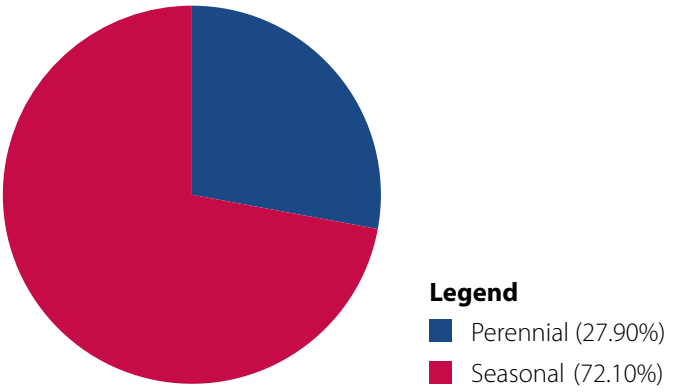


Figure 21. Distribution of water regime types of IVSs.

Chiefdom		Spring	Stream	Total
Gbonkolenken	Frequency (f)	10	34	44
	% within chiefdom	22.7%	77.3%	100.0%
Kafe Simira	(f)	6	35	41
	% within chiefdom	14.6%	85.4%	100.0%
Kalansogoia	(f)	16	6	22
	% within chiefdom	72.7%	27.3%	100.0%
Kholifa Rowala	(f)	24	75	99
	% within chiefdom	27.1%	73.0%	100.0%
Kholifa Mabang	(f)	2	23	25
	% within chiefdom	8.0%	92.0%	100.0%
Kunike	(f)	25	65	90
	% within chiefdom	28.7%	71.3%	100.0%
Kunike Barina	(f)	18	10	28
	% within chiefdom	64.3%	35.7%	100.0%
Malal Mara	(f)	8	20	28
	% within chiefdom	24.3%	75.8%	100.0%
Sambaia	(f)	3	44	47
	% within chiefdom	5.4%	94.7%	100.0%
Tane	(f)	22	24	46
	% within chiefdom	47.8%	52.2%	100.0%
Yoni	(f)	37	92	129
	% within chiefdom	28.7%	71.3%	100.0%
Total	**(f)**	**171**	**428**	**599**
	% within chiefdom	**28.5%**	**71.5%**	**100.0%**

Table 22. Types of water sources for IVSs, by chiefdom.

Chiefdom		Perennial	Seasonal	Total
Gbonkolenken	Frequency (f)	8	36	44
	% within chiefdom	18.2%	81.8%	100.0%
Kafe Simira	(f)	17	24	41
	% within chiefdom	41.5%	58.5%	100.0%
Kalansogoia	(f)	8	14	22
	% within chiefdom	36.4%	63.6%	100.0%
Kholifa Rowala	(f)	25	74	99
	% within chiefdom	17.8%	82.2%	100.0%
Kholifa Mabang	(f)	3	22	25
	% within chiefdom	12.0%	88.0%	100.0%
Kunike	(f)	23	67	90
	% within chiefdom	29.4%	70.6%	100.0%
Kunike Barina	(f)	11	17	28
	% within chiefdom	39.3%	60.7%	100.0%
Malal Mara	(f)	4	24	28
	% within chiefdom	33.4%	66.7%	100.0%
Sambaia	(f)	38	9	47
	% within chiefdom	81.4%	18.6%	100.0%
Tane	(f)	2	44	46
	% within chiefdom	4.3%	95.7%	100.0%
Yoni	(f)	28	101	129
	% within chiefdom	21.7%	78.3%	100.0%
Total	**(f)**	**167**	**432**	**599**
	Total % within IVSs	**27.9%**	**72.1%**	**100.0%**

Table 23. Distribution of IVS water regime types within chiefdoms.

Duration of surface water

For seasonal swamps, the duration of surface water also determines the number of crops of rice and/or the methods that can be recommended for using IVSs during the off season. Approximately 73% of IVSs have surface water for 4–8 months of the year (Table 24). At least one crop of rice is assured in these cases, followed by another food crop during the second season. For pond culture, perennial sites with 12 months of surface water should be developed rather than those with only 6–8 months of water supply.

Duration	Frequency	Percentage
4–6 months	250.0	41.7
7–8 months	187.0	31.2
9–10 months	161.0	26.9
No response	1.0	0.2
Total	**599**	**100.0**

Table 24. Distribution of IVS surface water by duration.

Depth of flooding

The extent of flooding in IVSs has technical implications regarding the types of crops that can be established, as well as the engineering requirements for water control. Information on the areal extent of flooding can be used to identify varieties of rice that can be established along the toposequence of the swamp, according to the water requirements of these varieties. Requirements for water control structures are also determined by the degree of flooding in a swamp. Figures 22 and 23 show the depth of flooding at the middle and edge of swamps, respectively. Ninety-four percent of IVSs have a flooding depth ranging from 30–100 cm in the middle of the swamp, and 93% have a depth of 10–20 cm at the edge.

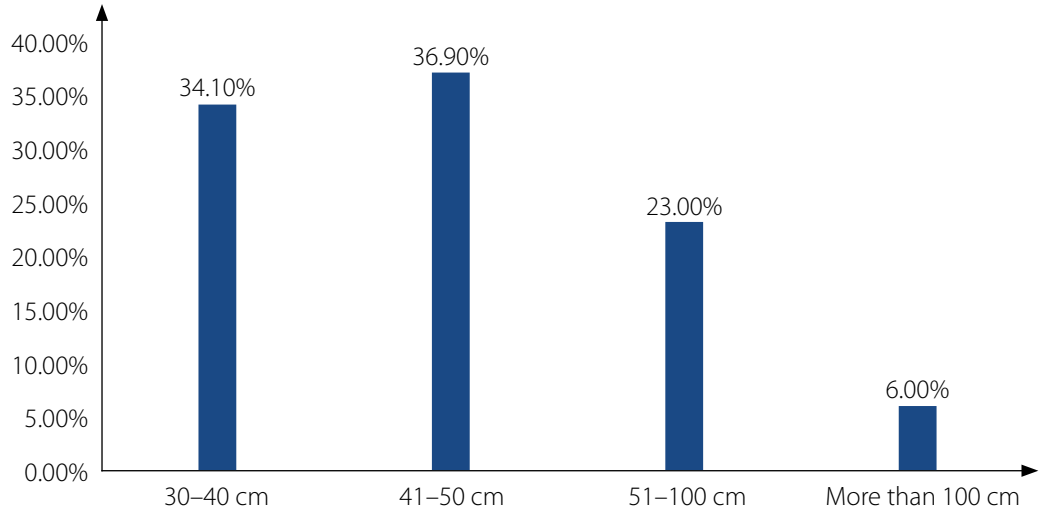


Figure 22. Distribution of flood depth in the middle of IVSs.

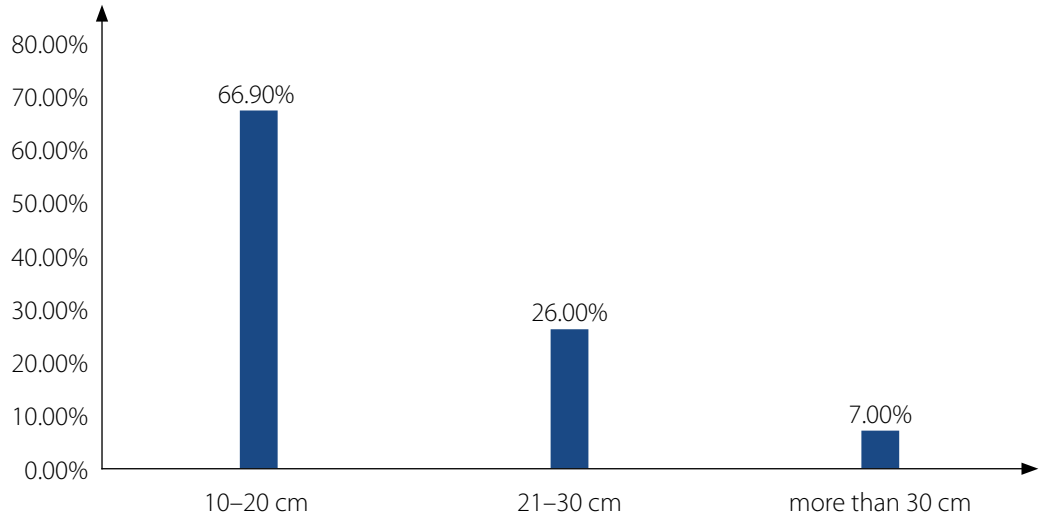


Figure 23. Distribution of flood depth at edge of IVSs.

Development status of IVSs

As shown in Figure 24, approximately 50% of swamps are undeveloped, while only 9.3% are fully developed.

IVS catchment vegetation

As shown in Figure 25, a little over one-third (34.2%) of IVS catchments are covered by a mixture of grassland and trees. The practice of clearing IVS catchment areas of vegetation cover exposes the soil to high rates of runoff and severe erosion, with sand deposited at the IVS valley bottom. Over a number of years, this may lead to declining yields from swamplands, especially under the traditional system of farming. SATS (1996) reported that in Kailahun District of Sierra Leone, IVS farmers observed a two-year fallow period because of exceptionally poor yields after four years of continuous cropping.

Preliminary ranking of IVSs by chiefdom

To gain insight into the potential of IVSs for any intervention, whether for crop production or aquaculture, the research team ranked the IVSs by chiefdom, using data relating to the nature of the water regime as well as the length of time surface water is present in the swamp. The nature of the water regime, whether seasonal or perennial, and length of water availability in an IVS in a year are critical to select suitable IVSs for fish farming. The ranking was determined using the methodology of SATS (1996), modified in this case by a weighting factor.

1. The "nature of the water regime" characteristic was assigned a ranking value ranging from 1 to 4, depending on the length of time water is present in the swamp (Table 25).

Duration of surface water		Ranking value
Perennial		4
Seasonal	9–10 months	3
	7–8 months	2
	4–6 months	1

Table 25. Ranking values used for different water regimes.

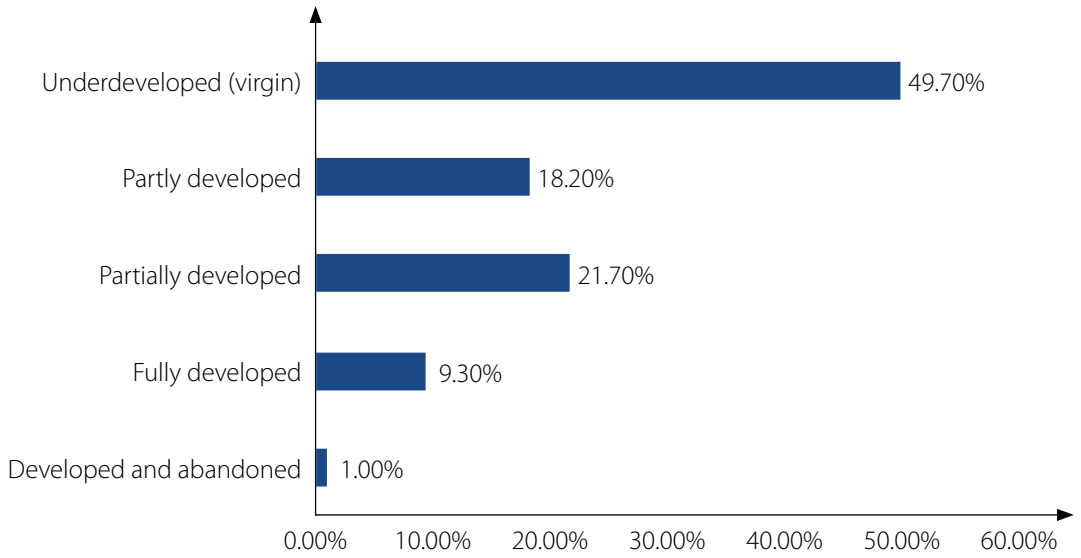


Figure 24. Distribution of IVSs by development status.

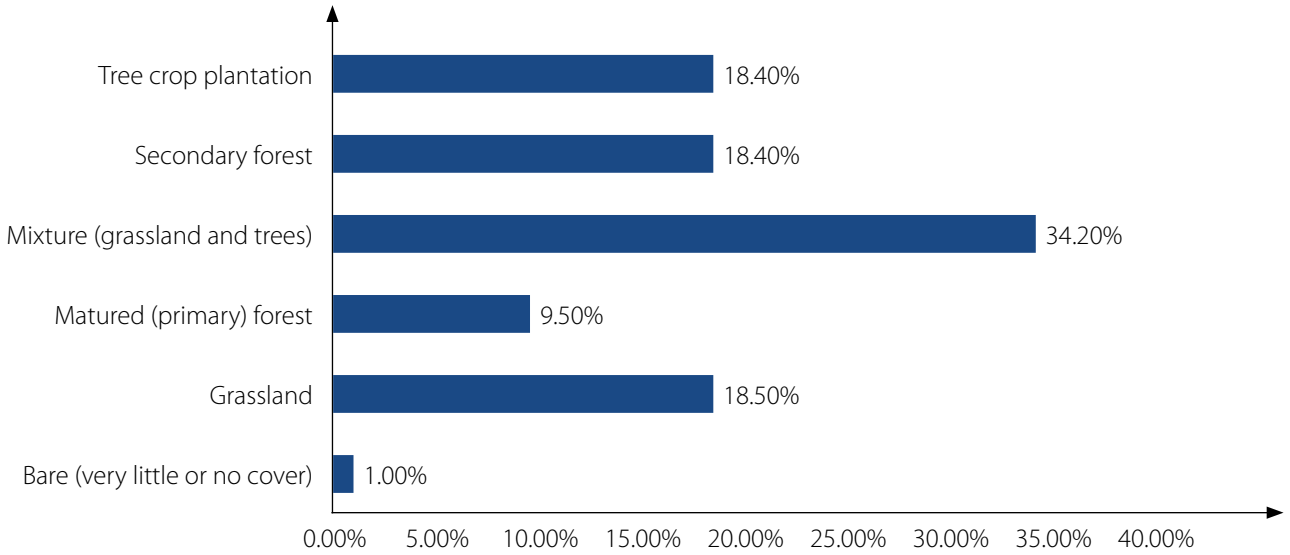


Figure 25. Distribution of the major vegetation types in IVS catchments.

2. Using the results in Table A8 (Appendix A), the ranking value was then multiplied by the percentage of swamps in each category of surface water duration, as indicated above. This produced a weighted score for the characteristic.
3. An aggregate score was then computed for each of the chiefdoms, and these scores were then ranked (Table 26).

Chiefdom	Aggregate Score	Rank
Sambaia	4.613	1
Kunike Barina	3.500	2
Kafe Simira	3.394	3
Kalansogoia	3.319	4
Malal Mara	3.271	5
Kunike	3.208	6
Gbonkolenken	2.955	7
Yoni	2.891	8
Kholifa Rowala	2.398	9
Kholifa Mabang	2.000	10
Tane	1.955	11

Table 26. Ranking of IVSs by chiefdom based on the nature of the water regime.

It is worth noting that the top four ranked chiefdoms are in the eastern/northeastern part of the district, which is generally hilly. It is possible that streams or spring sources are constantly fed from waters in the hilly catchment areas to provide a favorable water regime. It is also important to note that this ranking is only preliminary; other important factors, such as socioeconomic characteristics and past or present experiences in IVS use/fish culture, would have to be considered to create a final ranking of IVSs that could be used to select swamps for any intervention. Furthermore, it is imperative to undertake ground-truth visits during the peak dry season months of March and April to ascertain the water regime in perennial IVSs.

SECTION C: AQUACULTURE

Information on aquaculture

Ownership of fishponds

This study covered the distribution of ownership of fishponds in the 11 chiefdoms in Tonkolili District (Figure 26). Of the 600 respondents interviewed, only 77 (12.8%) own fishponds while 523 (87.2%) do not. The Kunike and Kunike Barina chiefdoms have the highest proportion (6.67% and 1.42%, respectively) of ownership of fishponds in the district, while the Kafe Simira, Kalansongoia and Sambaia chiefdoms do not have any fishpond owners. Tonkolili is one of the districts in Sierra Leone with the highest concentration of fishponds, but most of have been abandoned.

Regarding the location of fishponds in the 11 chiefdoms, inside or outside IVSs (Figure 27), Kunike and Kunike Barina have the highest number of fishponds in IVSs (38.9% and 35.7%, respectively). There were no fishpond owners in Kafe Simira, Kalansogoia, and Sambaia. Summary distribution showed that 8.94% of fishponds were located in IVSs. Those who responded negative either have their ponds outside IVS or do not own ponds.

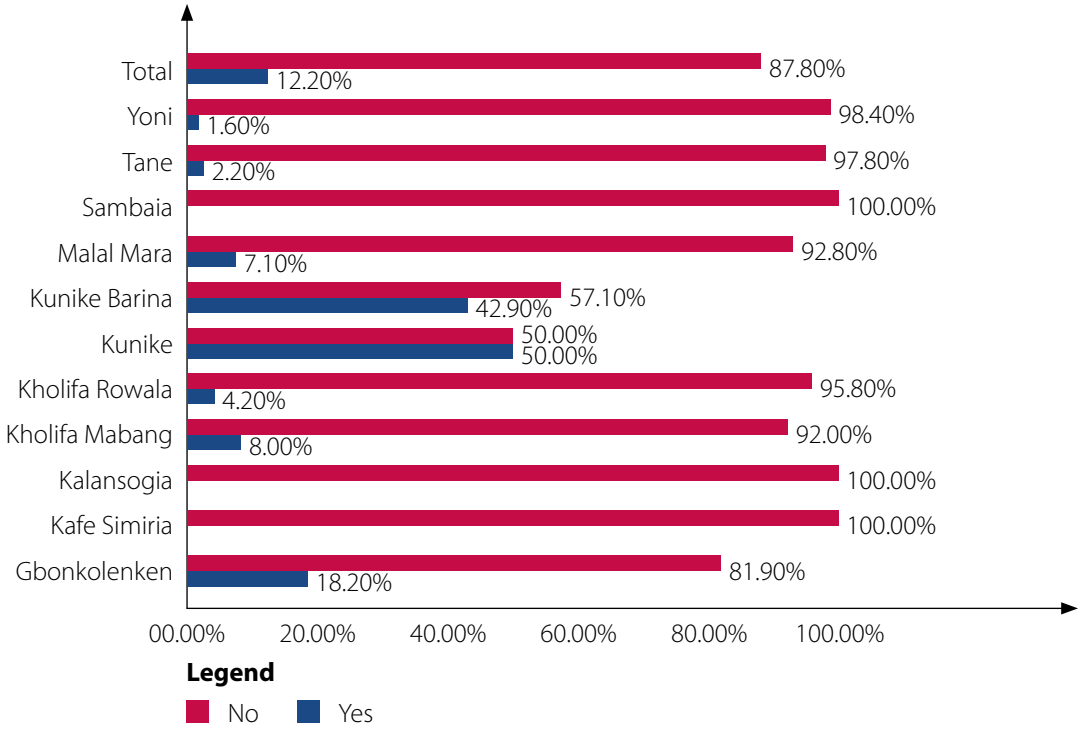


Figure 26. Ownership distribution of fishponds in Tonkolili District.

Figure 27. Location of fishponds within IVSs in chiefdoms in Tonkolili District.

Plate 14. Abandoned fishponds in the jungle (10 km away from the nearest village).

Information on number of fishponds owned by respondents

Out of 600 respondents sampled, those with at least one fishpond in Tonkolili District were highest in Kunike followed by Konike Barina and Gbonkolenken (Table 27). The proportion of respondents reporting ownership of three to five fishponds was highest in Kunike Barina, Konike and Globenken, respectively, while the respondents who said they have more than five fishponds were found only in Kunike and Kunike Barina.

Types of ponds owned

Of the ponds owned by respondents in the 11 chiefdoms in Tonkolili (Table 28), three types of rearing facilities were recorded: concrete tanks, dug holes and earthen ponds. Earthen ponds and dug holes were common in the 11 chiefdoms. The summary statistics of pond types in the district showed concrete tanks at 3%, dug holes at 0.2%, earthen ponds at 9.3%, plastic bowls at 0.5% and metal tanks at 0.2%.

Sources of fish seed

Quality fish seed is crucial to the success of any aquaculture enterprise. In Tonkolili District, fish seed is usually obtained from any of five different sources: (1) local hatcheries, (2) the wild, especially at the time of floodplain inundation, (3) NGOs and government ministries, (4) research institutions or (5) other farmers' farms. The summary distribution of the sources of fish seed (Figure 28) showed that the highest percentages of farmers in the district get their seeds from local hatcheries (3.8%), followed by other farmers' farms (3%) and then NGOs and government institutions (2.2%). The least common source is the wild (0.7%). The 88.7% of respondents who did not respond do not engage in fish farming at all or currently abandoned fish farming. The research institutions, which should be the sources of quality agricultural inputs such as fish seed, only supplied 1.7% to the farmers. This is not encouraging. It is clear that there is no single functional government-owned hatchery in the country. The Makali and Bo fish farms are often referred to as hatcheries for the

Chiefdom	No response	1–3	3–5	More than 5
Gbonkolenken	81.80%	15.90%	2.30%	0.00%
Kafe Simiria	100.00%	0.00%	0.00%	0.00%
Kalansogia	100.00%	0.00%	0.00%	0.00%
Kholifa Mabang	92.00%	8.00%	0.00%	0.00%
Kholifa Rowala	94.80%	3.10%	2.10%	0.00%
Kunike	50.00%	31.10%	17.80%	1.10%
Kunike Barina	60.70%	17.90%	17.90%	3.60%
Malal Mara	96.40%	3.60%	0.00%	0.00%
Sambaia	100.00%	0.00%	0.00%	0.00%
Tane	95.60%	2.20%	2.20%	0.00%
Yoni	98.40%	1.60%	0.00%	0.00%
Total	**87.30%**	**8.20%**	**4.20%**	**0.30%**

Table 27. Number of ponds owned by individual farmers in Tonkolili District.

Chiefdom	No response	Earthen ponds	Dug holes	Concrete tanks	Plastic bowls	Metal tanks
Gbonkolenken	81.80%	15.90%	0.00%	2.30%	0.00%	0.00%
Kafe Simiria	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Kalansogia	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Kholifa Mabang	92.00%	0.00%	0.00%	8.00%	0.00%	0.00%
Kholifa Rowala	95.80%	2.10%	0.00%	2.10%	0.00%	0.00%
Kunike	51.10%	38.90%	0.00%	6.70%	3.30%	0.00%
Kunike Barina	64.30%	35.70%	0.00%	0.00%	0.00%	0.00%
Malal Mara	92.90%	3.60%	0.00%	3.60%	0.00%	0.00%
Sambaia	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Tane	91.10%	2.20%	0.00%	6.70%	0.00%	0.00%
Yoni	96.00%	0.00%	0.80%	2.40%	0.00%	0.80%
Total	**86.90%**	**9.30%**	**0.20%**	**3.00%**	**0.50%**	**0.20%**

Table 28. Description of ponds owned in Tonkolili District.

production of fingerlings, especially Nile tilapia, but this is not accurate. The Makali Fish Farm has been abandoned for a long time, and the water supply to the farm was an issue. Meanwhile, the Bo Fish Farm exists in name only, with no efforts by the MFMR to run it sustainably. Recently, the WorldFish project rehabilitated the Makali Fish Farm and started the development of a Nile tilapia broodstock and fingerling production.

Fish production cycles

The number of respondents and percentage distribution of the number of fish production cycles in various chiefdoms of Tonkolili District is presented in Table 29. Two cycles of fish farming per year is a prominent method in Kunike (32.2%), Kunike Barina (35.7%), Gbonkolenken (13.6%), Tane (4,4%), Kholifa Rowala (2.1%), Kholifa Mabang 4.0%) and Mala Mara (3.6%), where perennial IVSs are abundant. This system of production is feasible in areas where tilapia or catfish is the culture species, since the two species will grow to table size in 5–6 months when provided with quality feed while living in well-fertilized ponds.

Production of fish once a year was more prominent in Kunike where only six respondents out of the 600 sampled agreed to farm fish once in a year. The farming of fish three times per year was recorded only in Kunike and Yoni. These two chiefdoms have extensive floodplains where fish breed at the peak of the rainy season, allowing farmers to culture and crop fish three times per year; however, most of these harvests are made up of juveniles and smaller fish meant only for household consumption.

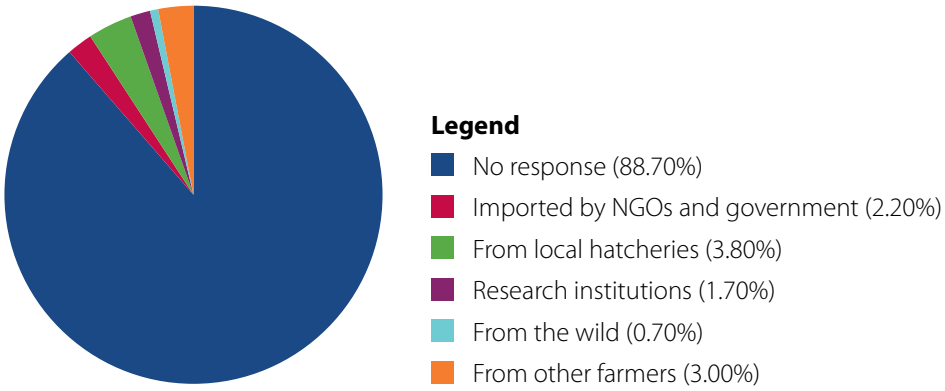


Figure 28. Sources of fish seeds in Tonkolili District.

Chiefdom	No response	One production cycle	Two production cycles	Three production cycles
Gbonkolenken	86.40%	0.00%	13.60%	0.00%
Kafe Simiria	100.00%	0.00%	0.00%	0.00%
Kalansogia	100.00%	0.00%	0.00%	0.00%
Kholifa Mabang	92.00%	4.00%	4.00%	0.00%
Kholifa Rowala	96.90%	1.00%	2.10%	0.00%
Kunike	54.40%	6.70%	32.20%	6.70%
Kunike Barina	60.70%	3.60%	35.70%	0.00%
Malal Mara	96.40%	0.00%	3.60%	0.00%
Sambaia	100.00%	0.00%	0.00%	0.00%
Tane	95.60%	0.00%	4.40%	0.00%
Yoni	99.20%	0.00%	0.00%	0.80%
Total	**88.80%**	**1.50%**	**8.50%**	**1.20%**

Table 29. Fish production cycles in Tonkolili District.

Seasonality of fish production

Seasonality of fish production in each of the 11 chiefdoms of Tonkolili District is presented in Table 30, while the overall percentage distribution is represented in Figure 29. Seasonality of production is not the same as the fish production cycles described above. Seasonality relates to the time of the year when fish culture takes place, rather than simply the number of times fish are cultured per year. Results from the assessment showed that production skewed toward year-round and the dry season. Notably, Kunike, Kunike Barina and Gbonkolenken operated using all three types of production, while Kholifa Rowala, Malal Mara and Yoni only produce fish in the dry season. Fish production during the dry season in these chiefdoms may be a result of the practice of dedicating the rainy season to the production of rice and other staple crops. The respondents might also misinterpret harvesting fish from the IVSs as producing fish in the dry season. Dry season production is more common than the other two methods. Sambaia, Kafe Simira and Kalansongoia were the only chiefdoms where fish appears not to be produced in any season.

Information on annual production estimates

Production estimates of farmers in the 11 chiefdoms are represented in Table 31, while Figure 30 shows the overall percentage distribution of annual production

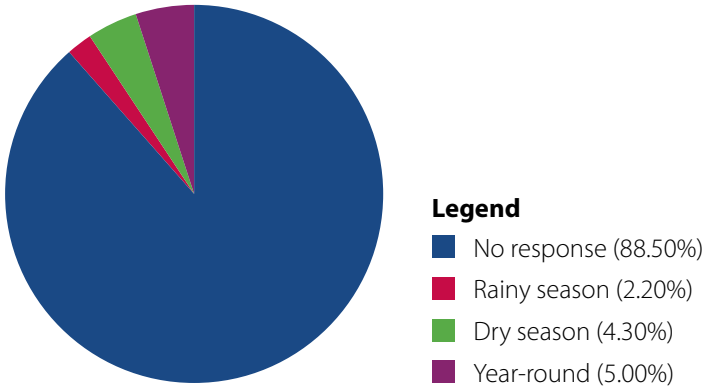


Figure 29. Overall seasonality of fish production in Tonkolili District.

Chiefdom	No response	Rainy season	Dry season	Year-round
Gbonkolenken	84.10%	6.80%	6.80%	2.30%
Kafe Simiria	100.00%	0.00%	0.00%	0.00%
Kalansogia	100.00%	0.00%	0.00%	0.00%
Kholifa Mabang	92.00%	0.00%	4.00%	4.00%
Kholifa Rowala	95.80%	0.00%	4.20%	0.00%
Kunike	54.40%	8.90%	7.80%	28.90%
Kunike Barina	60.70%	3.60%	32.10%	3.60%
Malal Mara	96.40%	0.00%	3.60%	0.00%
Sambaia	100.00%	0.00%	0.00%	0.00%
Tane	95.60%	2.20%	0.00%	2.20%
Yoni	99.20%	0.00%	0.80%	0.00%
Total	**88.50%**	**2.20%**	**4.30%**	**5.00%**

Table 30. Seasonality of fish production in Tonkolili District.

Chiefdom	No response	50–100 kg	101–150 kg	151–200 kg	201–300 kg	Over 300 kg
Gbonkolenken	86.40%	6.80%	2.30%	2.30%	0.00%	2.30%
Kafe Simiria	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Kalansogia	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Kholifa Mabang	92.00%	0.00%	4.00%	0.00%	4.00%	0.00%
Kholifa Rowala	95.80%	0.00%	2.10%	1.00%	0.00%	1.00%
Kunike	54.40%	10.00%	12.20%	11.10%	1.10%	11.10%
Kunike Barina	60.70%	3.60%	7.10%	0.00%	0.00%	28.60%
Malal Mara	96.40%	0.00%	3.60%	0.00%	0.00%	0.00%
Sambaia	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Tane	97.80%	0.00%	2.20%	0.00%	0.00%	0.00%
Yoni	99.20%	0.80%	0.00%	0.00%	0.00%	0.00%
Total	**88.80%**	**2.30%**	**3.20%**	**2.00%**	**0.30%**	**3.30%**

Table 31. Annual production estimates of fish production in Tonkolili District.

estimates in Tonkolili District. Annual fish production in terms of quantity harvested ranges from 50 to 300 kg, depending on pond size, which ranges from 100 to 400 m^2. The Kunike Barina, Kunike, Gbonkolenken, Kholifa Rowala and Yoni chiefdoms produced more than 300 kg of fish per year. Tane is the only chiefdom with an annual total production estimate of 101–150 kg. No fish farming activities appear to take place in Sambaia, Malal Mara, Kalansogoia or Kafe Simira. Figure 30 shows that the percentage distribution of annual production estimates in the entire district was highest for the over 300 kg category (3.3%), closely followed by 101–150 kg (3.2%) and finally 201–300 kg (0.3%). The annual production estimates recorded for this survey are very low. This could be caused by various factors, including insufficient quality and quantity of fish nutrition, inadequate technical knowledge regarding improved fish culture technologies, or the use of genetically impoverished fish seed, such as poor quality fingerlings. Farmers often resort to using termites, ants, rice bran, beniseeds and other household leftovers to feed their fish without understanding the full dietary requirements of the fish. It is clear from the results in the district that the harvests are barely enough to meet the needs of the fish farmers' families, with none left over to sell.

Quantity of fish consumed

Table 32 shows the quantity of fish consumed by respondents per household per annum while Figure 31 presents the overall distribution of the amount of fish consumed by respondents, both in Tonkolili District. Fish is consumed more in Kunike and Kunike Barina than in the rest of the chiefdoms.

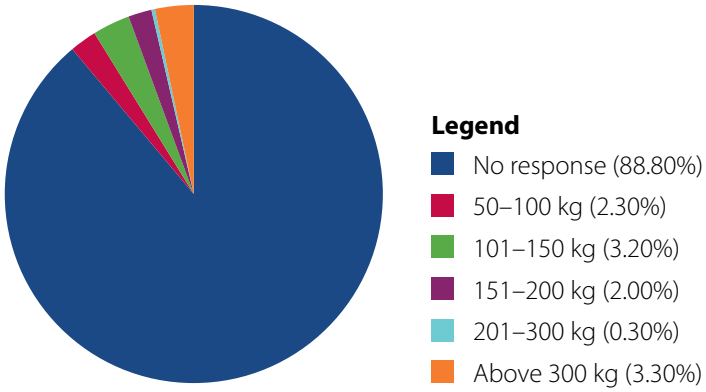


Figure 30. Percentage distribution of fish production estimates in Tonkolili District.

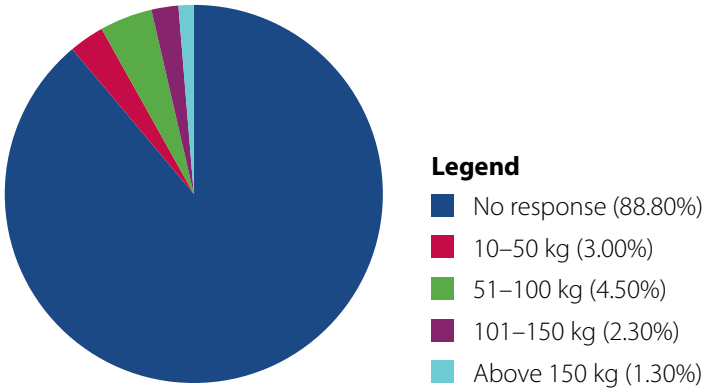


Figure 31. Overall annual fish consumption by households in Tonkolili District.

Chiefdom	No response	10–50 kg	51–100 kg	101–150 kg	Over 150 kg
Gbonkolenken	86.40%	6.80%	2.30%	2.30%	2.30%
Kafe Simiria	100.00%	0.00%	0.00%	0.00%	0.00%
Kalansogia	100.00%	0.00%	0.00%	0.00%	0.00%
Kholifa Mabang	92.00%	4.00%	4.00%	0.00%	0.00%
Kholifa Rowala	96.90%	1.00%	1.00%	1.00%	0.00%
Kunike	54.40%	14.40%	14.40%	10.00%	6.70%
Kunike Barina	60.70%	0.00%	35.70%	3.60%	0.00%
Malal Mara	96.40%	0.00%	0.00%	0.00%	3.60%
Sambaia	100.00%	0.00%	0.00%	0.00%	0.00%
Tane	95.60%	0.00%	0.00%	4.40%	0.00%
Yoni	99.20%	0.00%	0.80%	0.00%	0.00%
Total	**88.80%**	**3.00%**	**4.50%**	**2.30%**	**1.30%**

Table 32. Quantity of fish consumed by households in Tonkolili District.

Quantity of fish sold by farmers

Table 33 presents the amount of fish sold out of the total annual production estimate, while the overall percentage distribution of the quantity of fish sold in Tonkolili District is presented in Figure 32. The total quantity of fish sold ranges from 4.73 to 9.46 t per year, which include fish from aquaculture as well as from capture fisheries. However, these amounts do not represent the demand for freshwater fish in the district. The quantity sold represents only the low production levels of farmed and captured freshwater fish. Fish are usually sold in piles of about four to six and sometimes up to 10 for very small fish. The price of each fish pile is relative to the size of the fish and varies from SLL 2000 to SLL 10,000/kg. More fish are sold in Kunike, Kunike Barina and Gbonkolenke than in the other chiefdoms, which may be explained by the high proportion of floodplains and IVSs available in these three chiefdoms. Chiefdoms with vast floodplains and numerous IVSs have more kilograms of fish harvested than the other chiefdoms, which have relatively low plains and IVSs. Figure 32 clearly shows that more fish are sold within the 50–100 kg category (4%) while the lowest sales (0.3%) were recorded for the 201–300 kg category.

Integrated farming practices

Table 34 presents the respondents' answers to engagement in integrated farming in the 11 chiefdoms, while the overall percentage distribution of integrated farming system in Tonkolili District is presented in Figure 33. Among the 600 respondents sampled, only 9.61% said that they combine fish farming with other agricultural practices in the district (Figure 33). The practice of combining fish culture with other agricultural practices ranks highest in the Kunike and Kunike Barina chiefdoms. The practice was not common in Kafe Simira, Kalasongoia, Sambala and Yoni.

Chiefdom	Yes	No
Gbonkolenken	9.10%	90.90%
Kafe Simiria	0.00%	100.00%
Kalansogia	0.00%	100.00%
Kholifa Mabang	8.00%	92.00%
Kholifa Rowala	3.10%	96.80%
Kunike	36.40%	63.60%
Kunike Barina	40.90%	59.10%
Malal Mara	3.70%	96.30%
Sambaia	0.00%	100.00%
Tane	4.50%	95.50%
Yoni	0.00%	100.00%
Total	**9.61%**	**90.38%**

Table 34. Integrated farming practices in Tonkolili District.

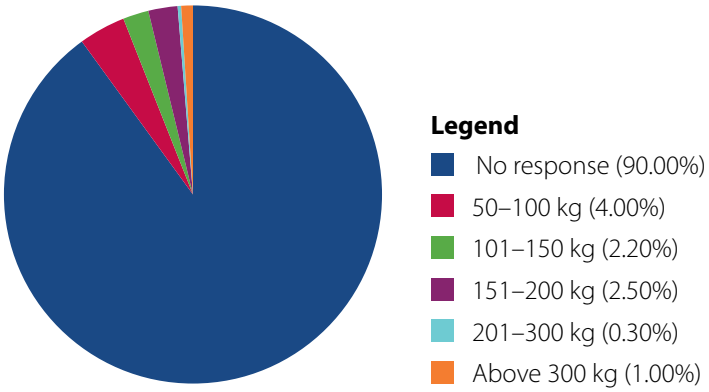


Figure 32. Distribution of quantity of fish sold in Tonkolili District.

Chiefdom	No response	50–100 kg	101–150 kg	151–200 kg	201–300 kg	Over 300 kg
Gbonkolenken	88.60%	4.50%	4.50%	2.30%	0.00%	0.00%
Kafe Simiria	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Kalansogia	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Kholifa Mabang	92.00%	0.00%	8.00%	0.00%	0.00%	0.00%
Kholifa Rowala	96.90%	0.00%	3.10%	0.00%	0.00%	0.00%
Kunike	60.00%	20.00%	5.60%	6.70%	2.20%	5.60%
Kunike Barina	60.70%	7.10%	3.60%	25.00%	0.00%	3.60%
Malal Mara	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Sambaia	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Tane	95.60%	4.40%	0.00%	0.00%	0.00%	0.00%
Yoni	99.20%	0.00%	0.00%	0.80%	0.00%	0.00%
Total	**90.00%**	**4.00%**	**2.20%**	**2.50%**	**0.30%**	**1.00%**

Table 33. Quantity of fish sold per year to markets by farmers in Tonkolili District.

Fish farming as alternate to crop farming

In Tonkolili District, the farming of fish after crop production is practiced in some of the chiefdoms. Out of the 600 respondents sampled, only 5.89% agreed to practice fish farming after crop production (Table 35). Among all the chiefdoms in the district, Kunike Barina and Kunike ranked highest in the practice of alternate farming.

Chiefdom	Yes	No	Total
Gbonkolenken	6.80%	93.20%	100.00%
Kafe Simira	0.00%	100.00%	100.00%
Kalansogoia	0.00%	100.00%	100.00%
Kholifa Mabang	0.00%	100.00%	100.00%
Kholifa Rowala	0.00%	100.00%	100.00%
Kunike	13.70%	86.30%	100.00%
Kunike Barina	31.80%	68.20%	100.00%
Malal Mara	0.00%	100.00%	100.00%
Sambaia	0.00%	100.00%	100.00%
Tane	0.00%	100.00%	100.00%
Yoni	0.80%	99.20%	100.00%
Total	**5.89%**	**94.10%**	**99.99%**

Table 35. Farming fish after crop production.

Types of fish feed used

Variations in the types of fish feed used in Tonkolili District are presented in Figure 34. Rice bran is the most common feed type (8.6%), followed by termites (6.2%) and cassava peelings (60%). Rice bran is the most common feed type because rice is a staple food of Sierra Leone, so after milling, the bran is a readily available for fish feed. Bolgo (0.2%) and carrion (0.2%) are the least used feed types. Figure 34 shows that farmers are using feed ingredients as feed oppose to prepared feeds.

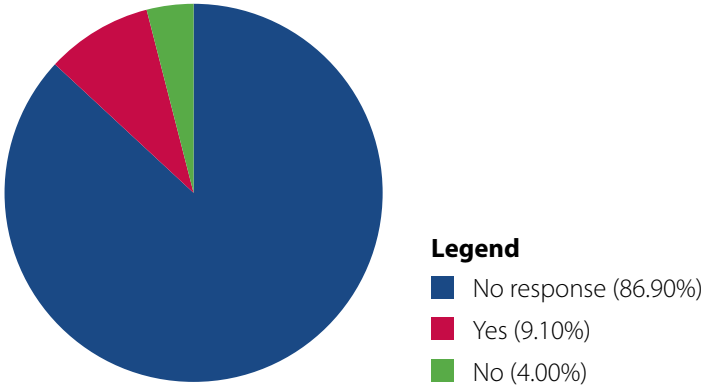


Figure 33. Overall distribution of fish culture with crop production.

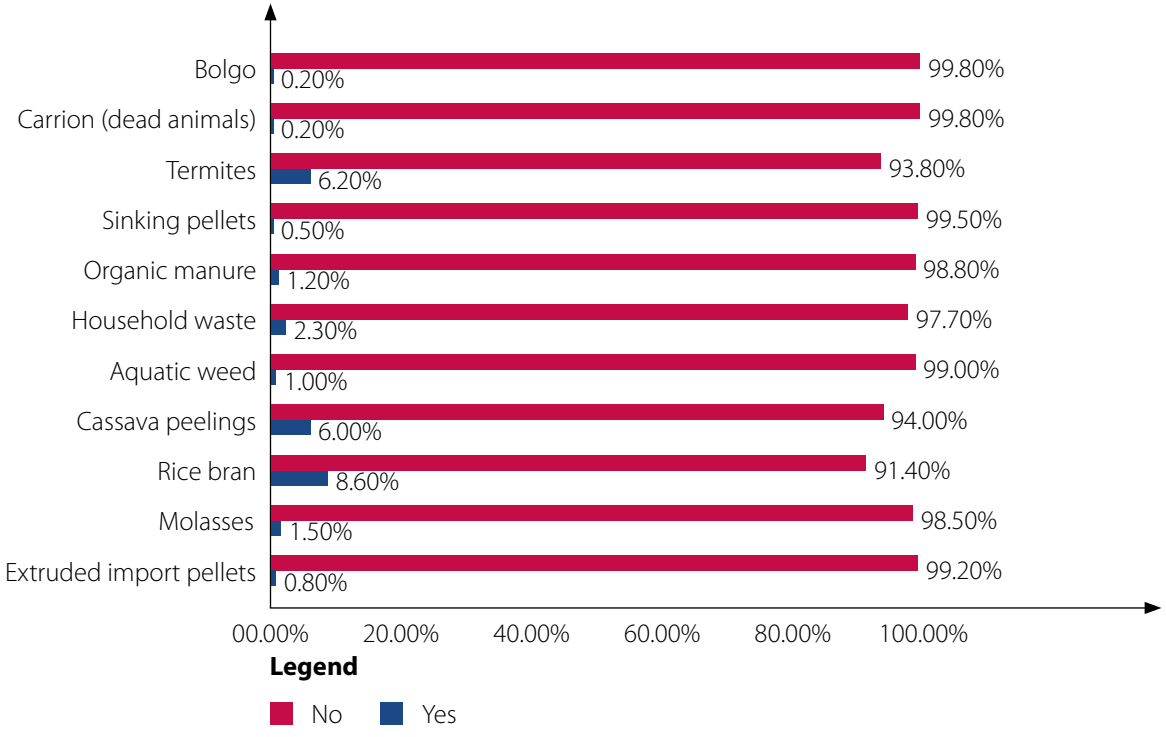


Figure 34. Fish feed types used by fish farmers in Tonkolili District.

Fish harvesting methods

Fish cropping, otherwise known as harvesting, can be done either partially or fully. Partial harvesting (9.8%) is mostly used in Tonkolili District (Figure 35). This preference is simply due to the fact that fish growth is variable: bigger fish are harvested first, thereby allowing the smaller ones to grow.

Labor for fish farming activities

It is uncommon for fish farmers in Tonkolili District to hire labor. As Figure 36 shows, only 5% of farmers reported hiring labor for their farming activities, possibly because there are many household hands that help with farming activities. Additionally, farmers' fishpond systems are not yet profitable enough to pay for hired labor on a part-time or daily basis. However, where pond construction is not done on communal basis, labor is often contracted out to a pond construction expert. Men play an active role in the construction and management of fishponds, while women and children carry out activities such as weeding, predator control, feeding and fish harvesting.

Data on hired labor

The percentage distribution of labor hired by respondents in Tonkolili District to do their work is reported in Figure 37. Of the respondents who hired laborers, those who hired more than three laborers (3.5%) ranked the highest, while those who hired three were lowest (0.5%).

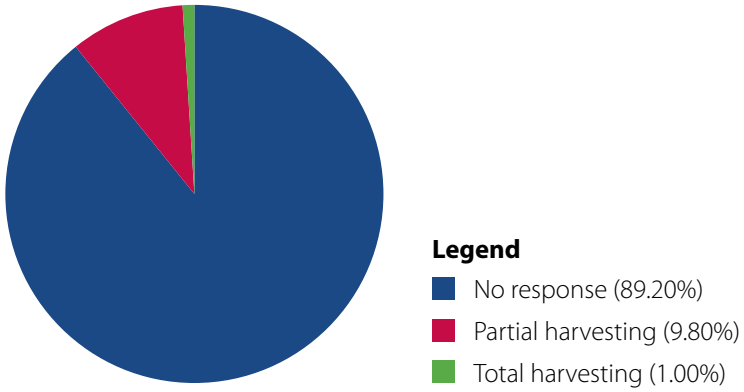


Figure 35. Harvesting methods used in Tonkolili District.

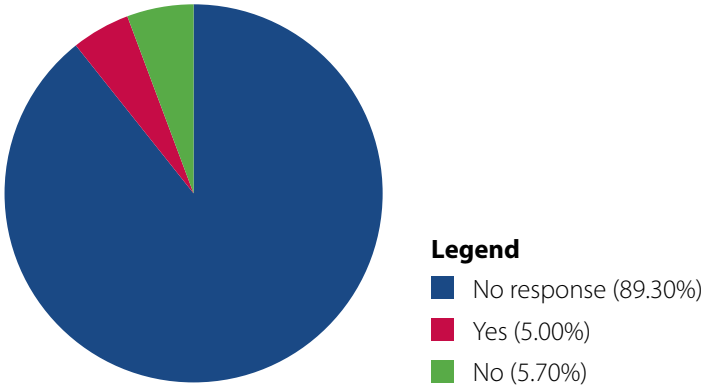


Figure 36. Labor hired by farmers in Tonkolili District.

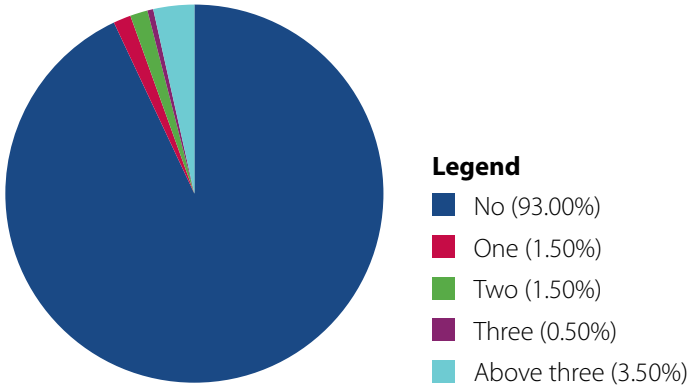


Figure 37. Percentage distribution of hired labor in Tonkolili District.

Price

The price at which fish (tilapia) is sold in Tonkolili District (Figure 38) ranges from SLL 5000 to SLL 15,000 (USD 1.01–3.03) per kg and sometimes higher. A kilogram or a pile of fish is sold most often at SLL 5000 (4.2%) than at other prices. A kilogram of fish sells least often at SLL 15,000 (0.3%) because of the availability of alternative meat sources, such as local fowl, bush meat and beef. Considering the breakeven farm gate price (4000-5000 SLL), SLL 10,000 (2.5%) is seen as a better price for farmed tilapia.

Adding value to fish through processing

Adding value to fish and fish products can enhance product acceptability among consumers, increase the shelf life of products and increase both the market price and market value. It also allows for the creation of different products from the same raw materials, whether in agriculture or aquaculture. Most fish and fish products are easily perishable, so adding value to them can be necessary, especially in rural communities where processing and preservation technologies are scarce or unavailable. The percentage distribution of respondents who add different types of value to fish and fish products and those who do not is presented in Figure 39. Those who add value to fish through processing comprised 3.7%, while 96.3% said they add none. It is clear from the results that fish production from these locations is hardly sufficient for household consumption, meaning that fish are not likely to be left over for processing.

Processing methods

The types of processing methods practiced by respondents in Tonkolili District include smoking, sun drying, filleting, grilling, frying, chunking, cutting into steaks and salting (Table 36). Smoking fish ranked highest (3.2%), while salting was the least common (0.2%). Filleting, grilling and chunking were rarely practiced.

Methods employed	Yes		No response	
	(%)	(f)	(%)	(f)
Smoking	3.2	19	96.8	581
Sun-drying	0.7	4	99.3	596
Filleting	0.0	0	100.0	600
Grilling	0.0	0	100.0	600
Frying	0.8	5	99.2	585
Chunking	0.0	0	100.0	600
Salting	0.2	1	99.8	599

Table 36. Fish processing methods used by farmers in Tonkolili District.

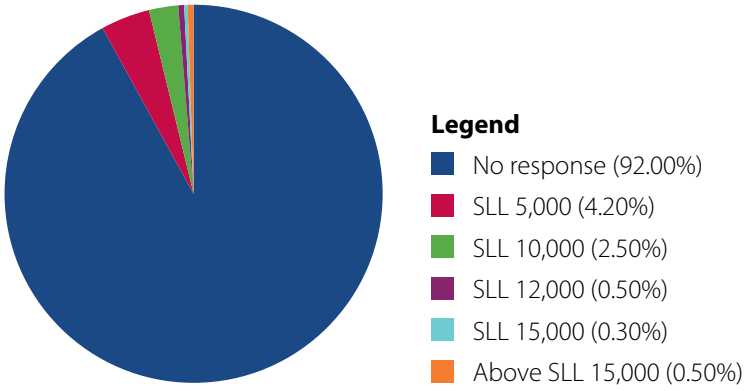


Figure 38. Distribution of the selling price of fish in Tonkolili District.

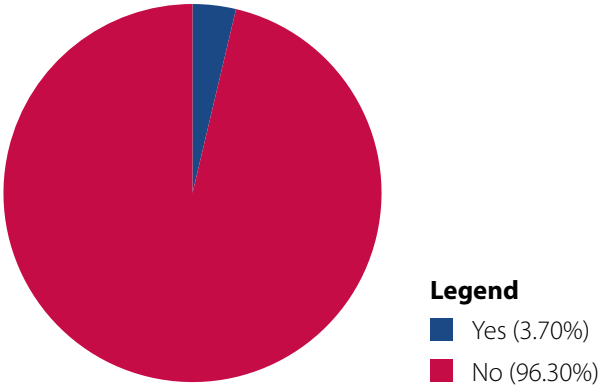


Figure 39. Information on value addition to fish in Tonkolili District.

Data on harvesting and selling fish

Total annual cost of labor

The cost of labor expended in the production of fish (for pond construction and maintenance) in Tonkolili per year is presented in Figure 40. The proportion of respondents who spent less than SLL 500,000 on labor per year was 3.7%, while 0.8% spent over SLL 4,000,000. A significant proportion (93.2%) of the 600 respondents sampled were indifferent to the question. These results show that most farm work is done using family labor. Tonkolili is predominantly Islamic, so many men are allowed to marry more than one wife. These polygamous units can have many children, which increases household farm labor because the children can assist the family with farm work once they are old enough.

Amount spent on fish feed

Quality feed given at the right time and in the right proportion is necessary for good fish growth and farm profitability. Figure 41 presents data on the amount of money respondents in Tonkolili District spend on fish feed per year. The data shows that feed is applied scarcely by farmers, which might account for the low annual turnover from the sector in the district. Farmers who spend between SLL 50,000 and 100,000 on fish feed accounted for just 4.2%, while those who spend SLL 100,001 to 150,000 were at 1.8%. Respondents who spend between SLL 200,001 and 300,000 accounted for 1.2% of the 600 respondents sampled. Of the remaining 89%, either no money was spent or no fish farming was done. The amount spent on fish feeding in Tonkolili District is very low when compared to what farmers elsewhere spend to raise their fish. This also indicates the majority of farmers do not practice feeding their fish.

Amount spent on organic manures

Organic manure added to ponds has the potential to fill the gap created by inadequate feed in the district, so it is not surprising that farmers spent more money to buy organic manure (Figure 42). Many of these farmers (3%) spent between SLL 50,000 and 100,000 on cow and poultry manure. A significant proportion (94.3%) among the 600 respondents sampled were indifferent to the question. Those farmers who spend more than SLL 300,000 annually accounted for just 0.5%. Organic manure, when correctly applied, can improve pond primary productivity (amount of natural food availability for fish in pond water), which boosts fish production in the long run. A good combination of quality fish feed and the right amount of manure therefore has the potential to change the face of fish farming in the district. However, the majority of farmers do not use these practices.

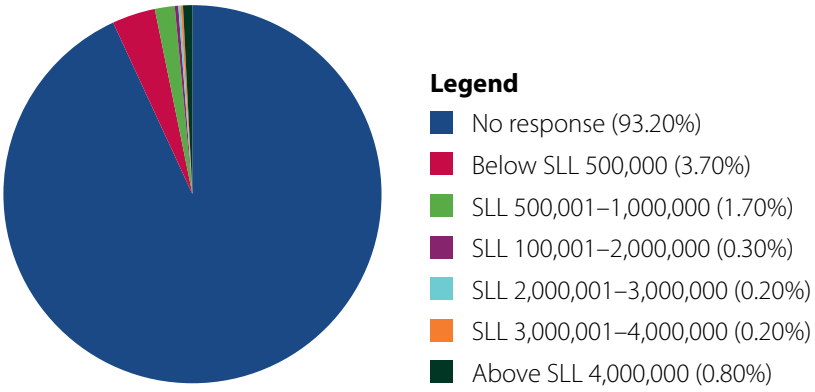


Figure 40. Annual labor cost for farmers in Tonkolili District.

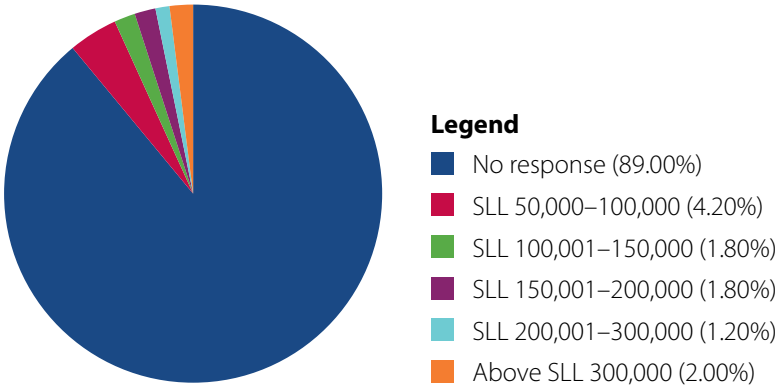


Figure 41. Information on what farmers spend on fish feed in Tonkolili District.

Amount spent on fish seed

Figure 43 presents data regarding the money spent by farmers in Tonkolili District on fish seed. Out of the 600 respondents sampled, the proportion spending less than SLL 500,000 to buy fish fingerlings annually was 6.7% while those who reported spending over SLL 4,000,000 was 0.5%. This latter information looks too good to be true, especially from the perspective of endemic poverty in the district.

Annual income from fish sales

Fish sales recorded in the district are presented in Figure 44. Of the 600 respondents sampled in the district, very few (4.2%) rarely sell more than SLL 1000,000 per year. A very high proportion (91%) of the sampled population prefer to remain uncommitted regarding what they make from fish sales annually. The quantity of fish kept for household consumption and the poor husbandry practices that caused a reduction in yield might have informed this low income from fish sales.

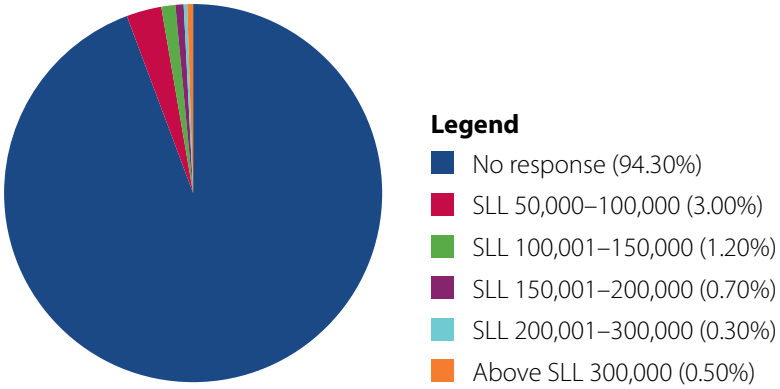


Figure 42. Money spent on organic manure in Tonkolili District.

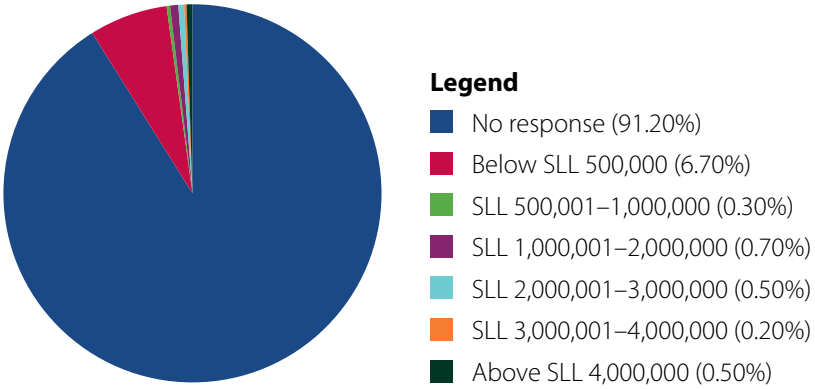


Figure 43. Information on what farmers spent to buy fish seed in Tonkolili District.

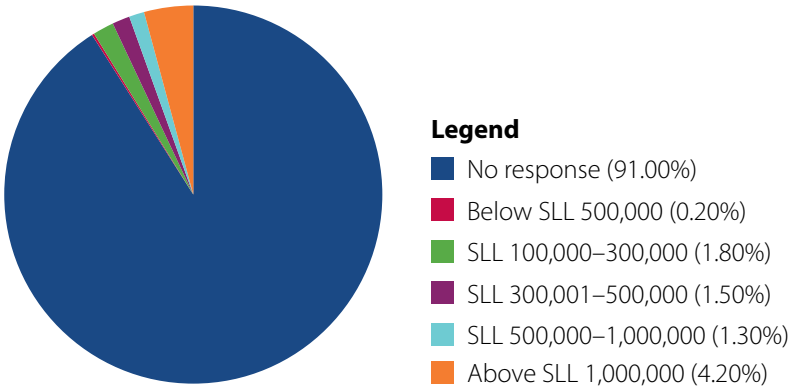


Figure 44. Annual income generated by farmers from fish sales in Tonkolili District.

Marketing and constraints

Membership in associations

Table 37 shows involvement in farmers groups among the 11 chiefdoms of Tonkolili District. Kunike, Kunike Barina and Kafe Simira had the highest percentage of membership among the chiefdoms, while Kholifa Rowala and Sambaia had the lowest. No respondents in Tane belonged to any farmers group. The overall percentage distribution of respondents who belong to farmers groups in Tonkolili District is only 10.18% (Figure 45).

Chiefdom	Yes	No
Gbonkolenken	13.60%	86.40%
Kafe Simiria	17.10%	82.90%
Kalansogia	9.10%	90.90%
Kholifa Mabang	4.00%	96.00%
Kholifa Rowala	2.10%	97.90%
Kunike	26.70%	73.30%
Kunike Barina	25.00%	75.00%
Malal Mara	10.70%	89.30%
Sambaia	2.10%	97.90%
Tane	0.00%	100.00%
Yoni	1.60%	98.40%

Table 37. Membership of associations in Tonkolili District.

Fish marketing

The outlets through which farmers sell fish in Tonkolili District are presented in Figure 46. Respondents reported seven primary outlets: (1) sales in the neighborhood, (2) sales to passersby on highways, (3) bartering fish among themselves, (4) sales in local markets, (5) sales to restaurants and eateries, (6) farm gate sales and (7) sales to wholesalers or middlemen. Of the outlets listed, farm gate sales was the highest and accounted for 4%, while fish exchange for rice and other staples was the lowest, accounting for 0.2% of the 600 respondents sampled. Most of the fish sold in the district come from rivers and those brought from the marine waters, and do not necessarily come from aquaculture.

Farmed fish in the Tonkolili market

African catfish and Nile tilapia are the two freshwater species most commonly cultured by the respondents in Tonkolili District. The sales performance of the two species is presented in Figure 47. Ten percent of respondents sell Nile tilapia in the local markets while only 2% sell African catfish, which provided the

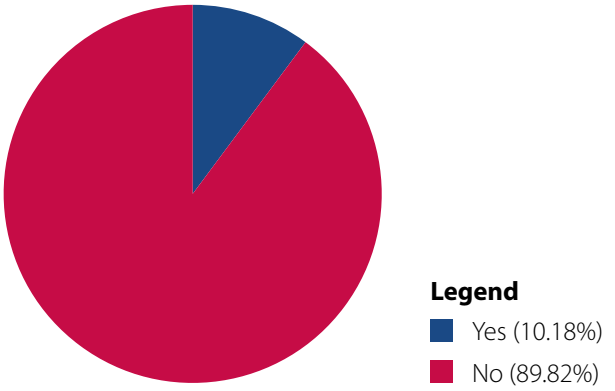


Figure 45. Overall distribution of membership.

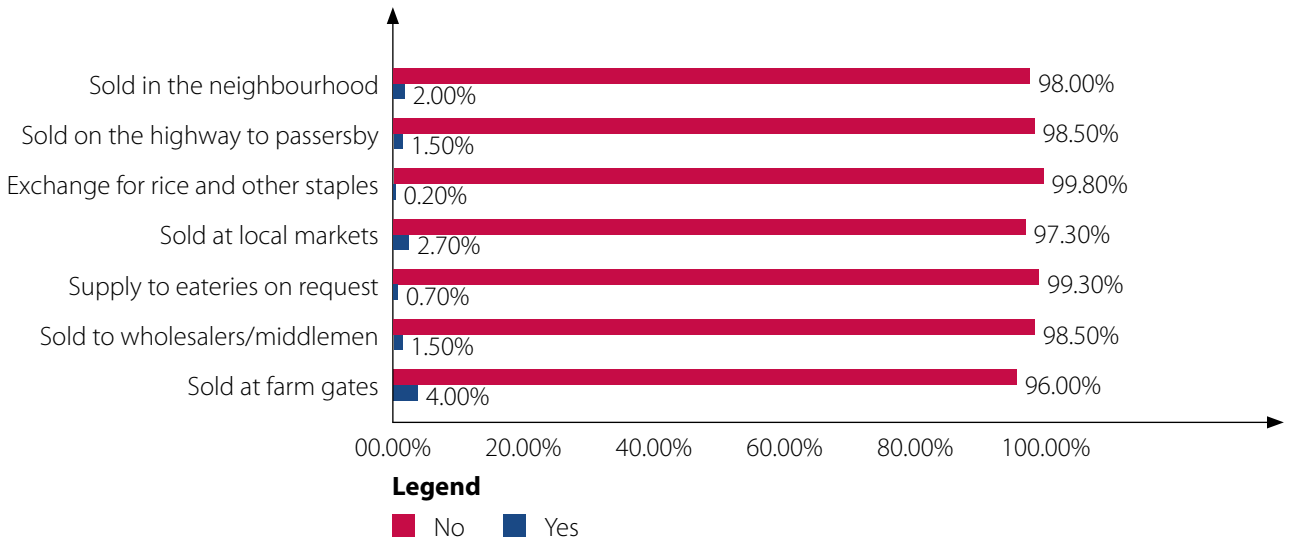


Figure 46. Marketing channels for sales of fish in Tonkolili District.

lowest income from sales. This trend may be due to the fact that tilapia are easier and cheaper to culture than catfish, which are carnivorous and require a more specialized diet. Tilapia are omnivorous and thrive on carbohydrates and vegetative materials, with adequate diets containing up to 28%–30% crude protein (CP). On the other hand, catfish will only grow to marketable size when provided with feed of a much higher CP content (up to 40%), which is more expensive. It is therefore easier to culture tilapia than to culture catfish, especially among the poor.

Constraints associated with fish marketing

Fish farming in Sierra Leone had a promising start in the early 1970s and progressed well into the 1980s, but it stalled after the decade-long civil war. Fish farming infrastructure and knowledge were practically destroyed, and the current revival of fish farming is limited by many factors. Constraints on fish marketing in Tonkolili District are presented in Figure 48. These include poor demand for fish among people who have become used to game hunting, exploitation of buyers by middlemen, high transportation cost and poor road networks. According to the information retrieved from the sampled respondents, low fish demand accounted for 5%, followed by poor road networks at 4.5%, while middlemen exploitation (0.3%) ranked lowest among the constraints. Low fish demand among rural people is associated with poor earning power—more than 90% of local people live on less than USD 1 per day.

Factors that determine fish preference

Figure 49 shows the different factors that influence respondents' preference for fish in Tonkolili District. These factors include availability, taste, price and social status. In both cases the sample size should be 600. Fish availability was the leading factor (8.8%) , while price was the least influential (0.2%) of the 547 respondents sampled. Since price is not a determinant for fish preference, increasing fish production from aquaculture and capture fisheries is expected to increase households' access to fresh fish. Both local and Nile tilapia species are ubiquitous in Sierra Leone and even thrive on their own. The availability of these species makes them cheap and affordable to the poor.

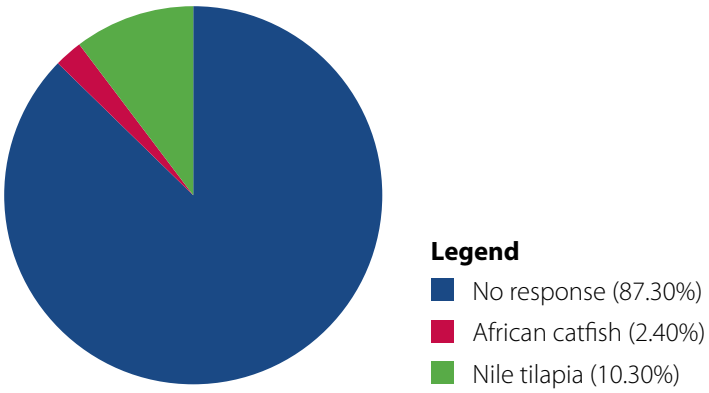


Figure 47. Freshwater fish species with the highest sales in Tonkolili District.

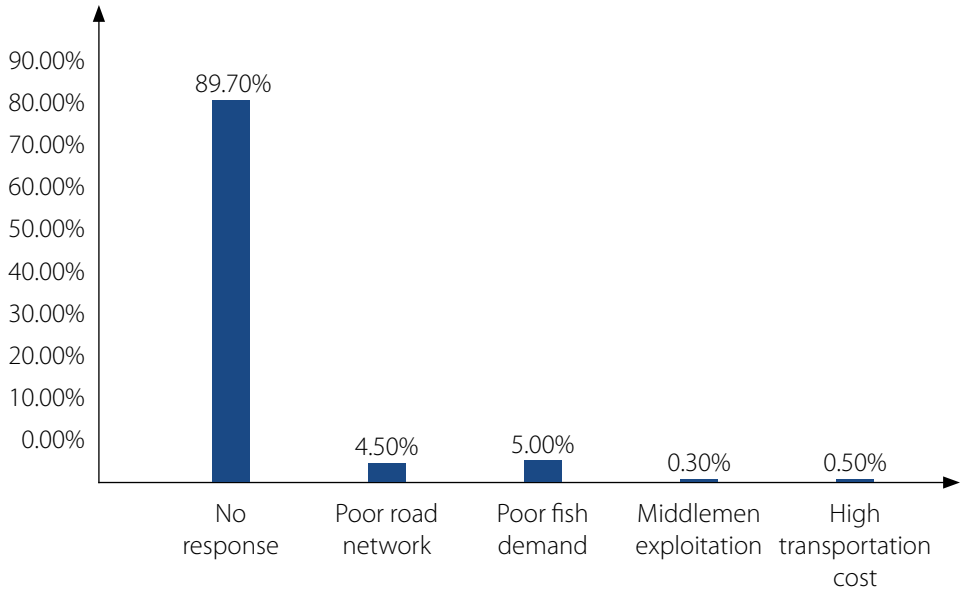


Figure 48. Problems associated with fish marketing in Tonkolili District.

Effect of scale of operation on fish yield

The scale of a fish farming operation implies the level of production intensity or the level of inputs used, which in turn affect farm yields. Figure 50 presents the perception on the effect of the scale of operation on fish yield in Tonkolili District. Of 600 respondents sampled, 4% indicated that the scale of operation is rarely sufficient to yield any profit while 5% said the scale is enough to earn profit.

Fish farming activities in the district are spasmodic and unorganized, and the scale is low. Serious intervention is required to improve upon the scale and introduce technically sound aquaculture in the district.

Reasons associated with low scale of operation

Figure 51 presents the reasons given by respondents for the low scale of operation in the district. These include low demand for cultured fish, high cost of fish feed, inadequate finance, diseases and depleting stock. Inadequate capital (6%) was considered the most serious followed by low demand for cultured fish (2%), while predators and depleting stocks ranked lowest (0.2% each). Although low demand was given as one of the reasons for the low scale of operation, the demand for cultured freshwater fish in the district has yet to be determined. It is possible that because of the cost of farming fish, the selling price per kilogram is beyond the reach of the generally poor people of the district.

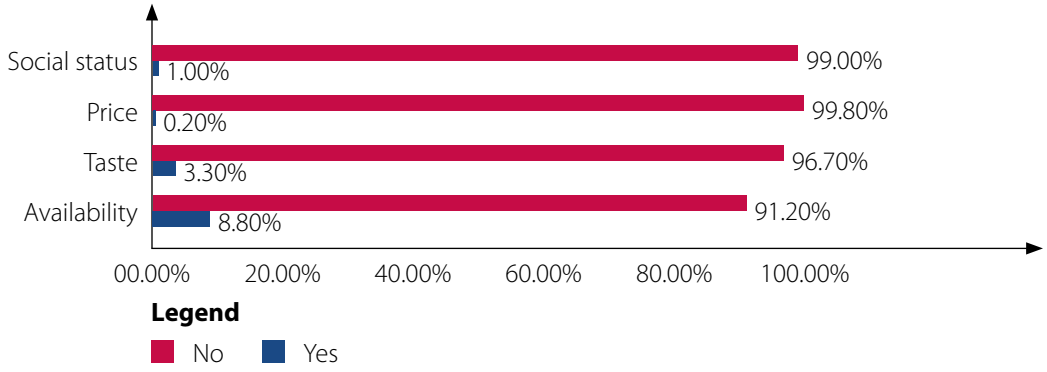


Figure 49. Factors that determine preferences for fish in Tonkolili District.

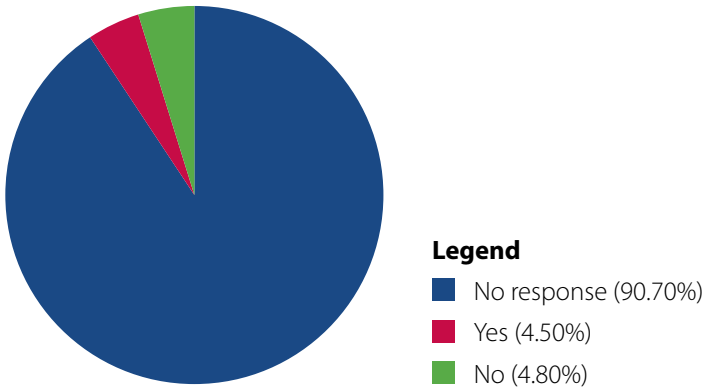


Figure 50. Perception about the effect of scale of operation on yield.

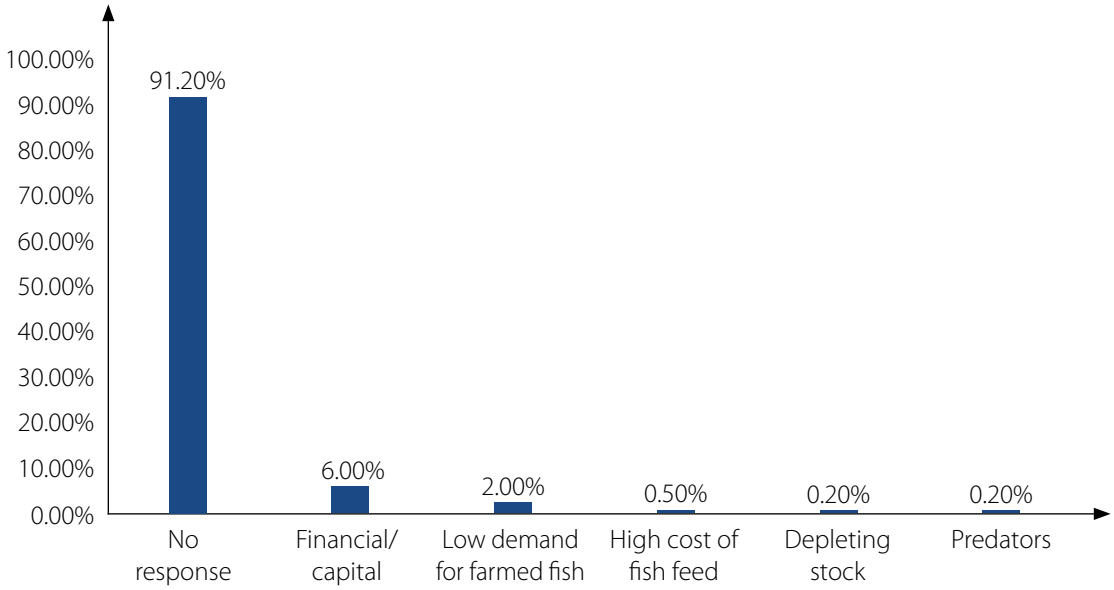


Figure 51. Reasons for low scale of fish farming operations in Tonkolili District.

Loan sources

Loan sources for fish farm establishment

Credit sources that farmers in the 11 chiefdoms use include bank loans, loans from cooperative societies, support from friends and relatives, grants from NGOs, personal savings and informal savings groups (Table 38). Some of the respondents (25.5%) did not report using credit facilities from any of the sources listed above, so they are categorized (not applicable) as not having taken any loans or credit. Respondents rarely accessed bank loans (1.5%), which were used in only four of the 11 chiefdoms. The most common sources of financial support come from personal savings (58%) and from friends (11%). NGOs (0.2%), informal groups (2.3%) and cooperative societies contributed insignificantly. Farmers rarely patronize banks for loans because of the high interest rates, which can be as high as 40% per year.

Repayment period of interest on loans

The repayment period for loans that farmers obtained varies from chiefdom to chiefdom (Figure 52). A repayment period of 1–2 years is usually imposed by lenders in all chiefdoms in Tonkolili District. Repayment periods exceeding 3 years were observed in only four of the 11 chiefdoms (Kafe Simira, Kholifa Maban, Kholifa Rowala and Gbonkolenken). Distribution of credit repayment periods in the district showed that repayment periods of 1–2 years were the most common (14%), while those exceeding 3 years were only 1% (Figure 53). The repayment period of 1–2 years in Tonkolili is better than in other districts, where rice farmers may be granted a period of only 3–4 months.

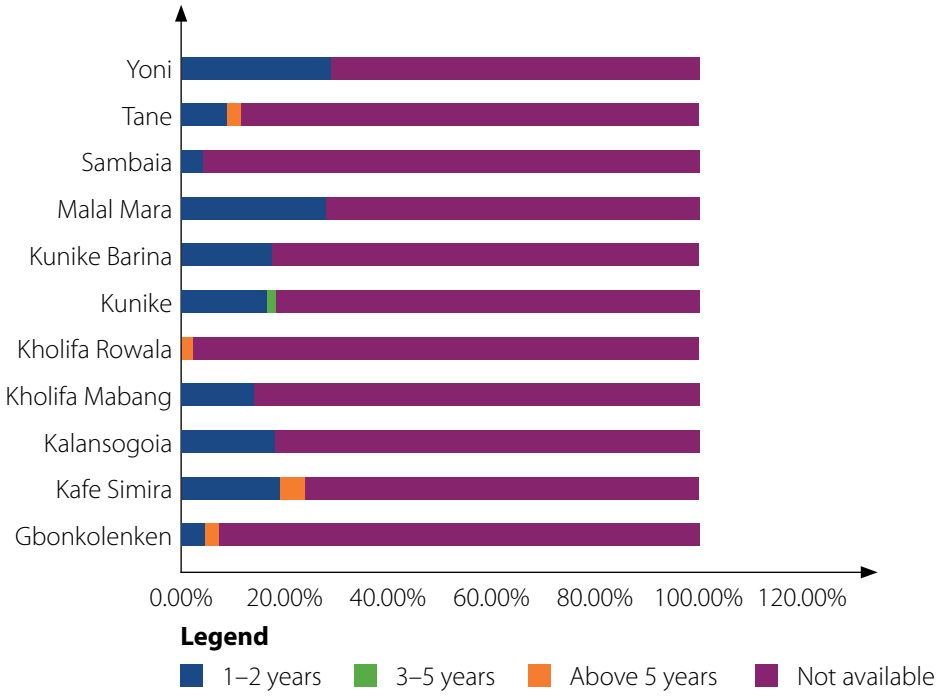


Figure 52. Duration of loans given to farmers in the 11 chiefdoms.

Chiefdom	Bank loans	Cooperatives	Friends and relatives	NGOs	NA	Personal savings	Informal savings groups
Gbonkolenken	0.0%	2.3%	9.1%	0.0%	40.9%	43.2%	4.5%
Kafe Simiria	0.0%	7.5%	5.0%	0.0%	7.5%	77.5%	2.5%
Kalansogoia	0.0%	0.0%	18.2%	0.0%	13.6%	63.6%	4.5%
Kholifa Maban	3.7%	3.7%	3.7%	0.0%	14.8%	70.4%	3.7%
Kholifa Rowala	0.0%	0.0%	15.3%	0.0%	3.1%	78.6%	3.1%
Kunike	4.3%	1.1%	11.8%	0.0%	41.9%	36.6%	4.3%
Kunike Barina	0.0%	0.0%	17.4%	0.0%	43.5%	34.8%	4.3%
Malal Mara	3.6%	0.0%	7.1%	0.0%	10.7%	78.6%	0.0%
Sambaia	0.0%	2.1%	10.6%	2.1%	70.2%	14.9%	0.0%
Tane	0.0%	0.0%	11.6%	0.0%	18.6%	69.8%	0.0%
Yoni	1.5%	0.8%	9.2%	0.0%	22.1%	65.6%	0.8%
Total	**1.5%**	**1.3%**	**11.0%**	**0.2%**	**25.5%**	**58.0%**	**2.3%**

Table 38. Loan sources for fish farm establishment in Tonkolili District.

Interest rate charges received by farmers on facilities

The interest rates charged by lending groups range from 11% to 20% per year (Figure 54). An interest rate of 5%–10% was most common among the respondents, and this was probably charged by cooperatives, village savings and loan associations and other lenders, because the rates of commercial banks are much higher. As interest rates soared, farmers became apathetic about accessing them, which may account for why the percentage of respondents who either did not access credit facilities or were not aware of the interest rates charged by the lending groups stood at 84.9%, showing a very low number of farmers involved in commercial-scale aquaculture operations in the district. It is not common to require collateral, but only individuals who have had an account for a period of time and who have a regular source of income can access bank loans. Most NGOs in the country prefer to work with clusters of farmers rather than individual ones for many reasons, including the advantage of collective actions such as sharing labor, access to credit, security of investment and the ease of pulling resources together for the common good.

Monetary value of loans or credit received by farmers

Regarding money received by respondents from various lending groups (Figure 55), 14.2% of the population said they receive loans ranging from SLL 1000,000 to 15,000,000 and higher. Those who have received more than SLL 15,000,000 made up

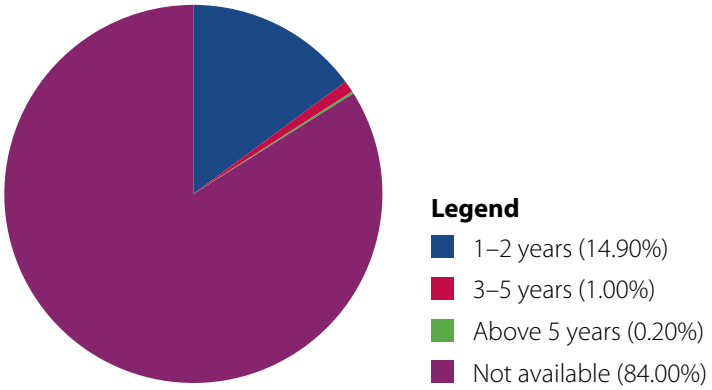


Figure 53. Repayment periods of loans in Tonkolili District.

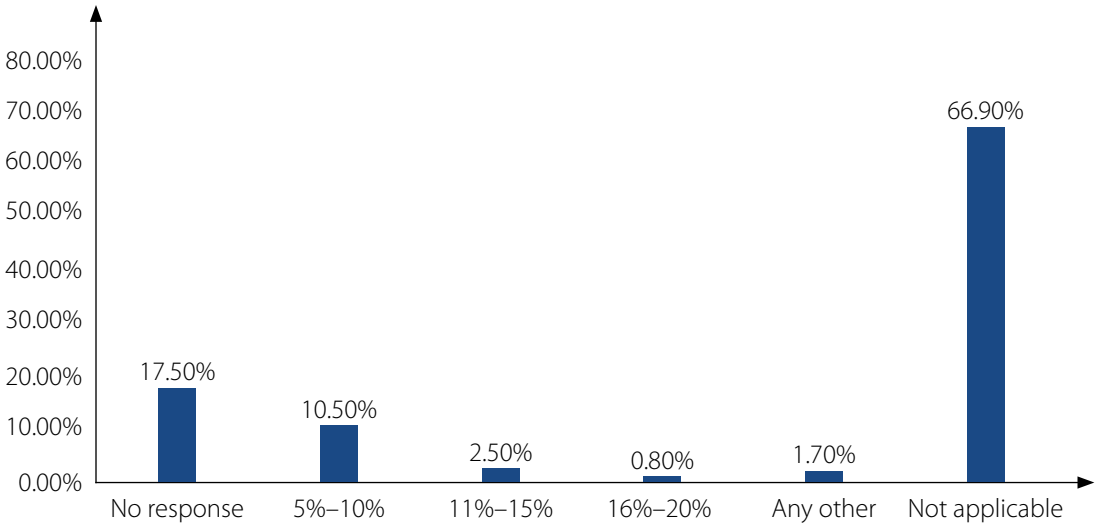


Figure 54. Interest per year payable by farmers in Tonkolili District.

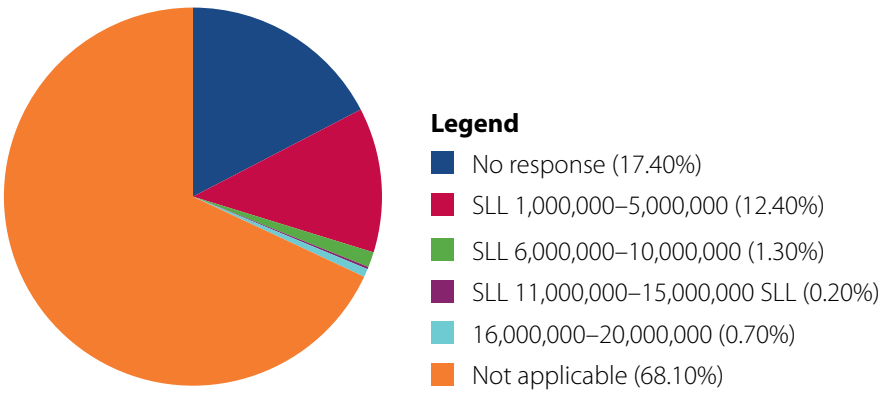


Figure 55. Monetary value of loans received by respondents, excluding interest.

85.7% of the respondents, while those who received between 6,000,000 and 10,000,000 comprised only 0.7%. Getting access to bank loans or other established group lending is often difficult unless the borrower is a government worker with a regular source of income or a strong member of society. Lenders are wary of people who previously received money and refuse to pay it back. It was reported that many borrowers often change their locations after receiving money. However, money can be received from lending groups if the borrower can provide collateral. The money quoted by the respondent is unduly high judging from the perspective of poverty in the district, but it is possible that some of the respondents who work for government or other organizations received money for purposes other than farming.

Level of awareness and adoption of integrated fish farming

The survey revealed that a greater percentage of the respondents were aware of the various integrated agricultural practices but did not adopt any, while 22%–25% were not aware of any (Figure 56). A total of 4%–13.8% of respondents are aware and adopt the farming system. The integrated practices include fish with rice and vegetables, fish with poultry and pigs, fish and tree crops only, fish with vegetables and goats, fish with vegetables, and rice and cows.

These awareness figures also relate to the level of local extension as well as availability of any written materials in local languages from the Ministry of Agriculture and/or the Ministry of Fisheries.

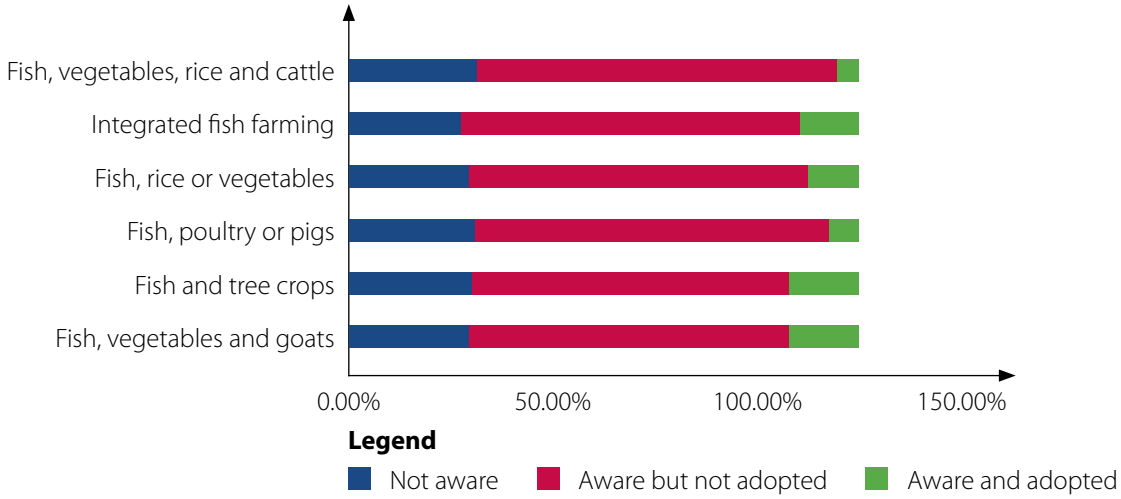


Figure 56. Awareness and adoption of integrated fish farming.

Variables	Strongly agree (SA)	Agree (A)	Disagree (D)	Strongly disagree (SD)	No response (NR)
Combines fish farming with crop or animal husbandry	41.0%	50.8%	5.7%	0.3%	2.2%
Uses natural resources efficiently	31.0%	57%	6.8%	2.8%	2.3%
Ensures that wastes from each farming enterprise are appropriately used to increase production	30.7%	59.7%	7.2%	0.5%	2.0%
Maximizes productivity through optimal use of resources	29.8%	57.7%	9.0%	0.8%	2.5%
Minimizes cost of fish production, especially fish feed	30.7%	53.7%	10.8%	1.3%	3.5%
Safeguards the environment from pollution	34.2%	52.3%	10.0%	1.5%	2.0%
Provides other sources of income, rather than only one from fish farming	37.0%	53.2%	7.0%	0.5%	2.3%
Finds integrated fish farming is more profitable than fish farming alone	32.0%	57%	7.7%	0.7%	2.7%
Diversifies financial risk by rearing fish, animals and crops	27.3%	56.2%	12.7%	1.7%	2.2%
Can improve income status of the rural farmer and reduction of poverty level among fish farmers	36.2%	55.3%	5.8%	0.3%	2.3%
	SA	**A**	**D**	**SD**	**NR**
Total	**33.0%**	**55.3%**	**8.3%**	**1.0%**	**2.4%**

Table 39. Perceptions of fish farmers regarding sustainable IAA.

Perception of fish farmers regarding sustainable IAA

One-third of the respondents (33%) said they "strongly agree" that IAA is beneficial and 55.3% said they "agree," while 8.3% disagreed that the practice holds any benefit (Table 39). Only 1% strongly disagreed, while 2.4% had no answers to the questions.

Fish species in IVSs

Use of fish species from IVSs

Use of freshwater fish from IVSs is common among all of the chiefdoms (Figure 57). Kholifa Mabang, Kunike Barina and Gbonkolenken ranked highest, while Kafe Simira and Kalasongoia were the lowest. Overall, respondents had a positive perception on the use of fish from the IVSs in Tonkolili District (Figure 58).

Seasonal annual calendar for fishing

Fishing activities in Tonkolili District take place throughout the year, in both dry and rainy seasons (Figure 59). Fishing for wild fish occurred more often during the dry season (45.7%) than at any other time, while fishing in the rainy season accounted for 31.2% and year-round fishing 23.0%. In almost all of the IVSs, fishing takes place in the rainy season, especially in the months of May and June, when fish come to breed in the floodplain. Fishing also takes place in the dry season in November, December and January, when water in the IVSs has receded and certain wild fish become more accessible.

A majority (57%) of the respondents reported fishing in IVSs on a seasonal basis, at the onset of the dry

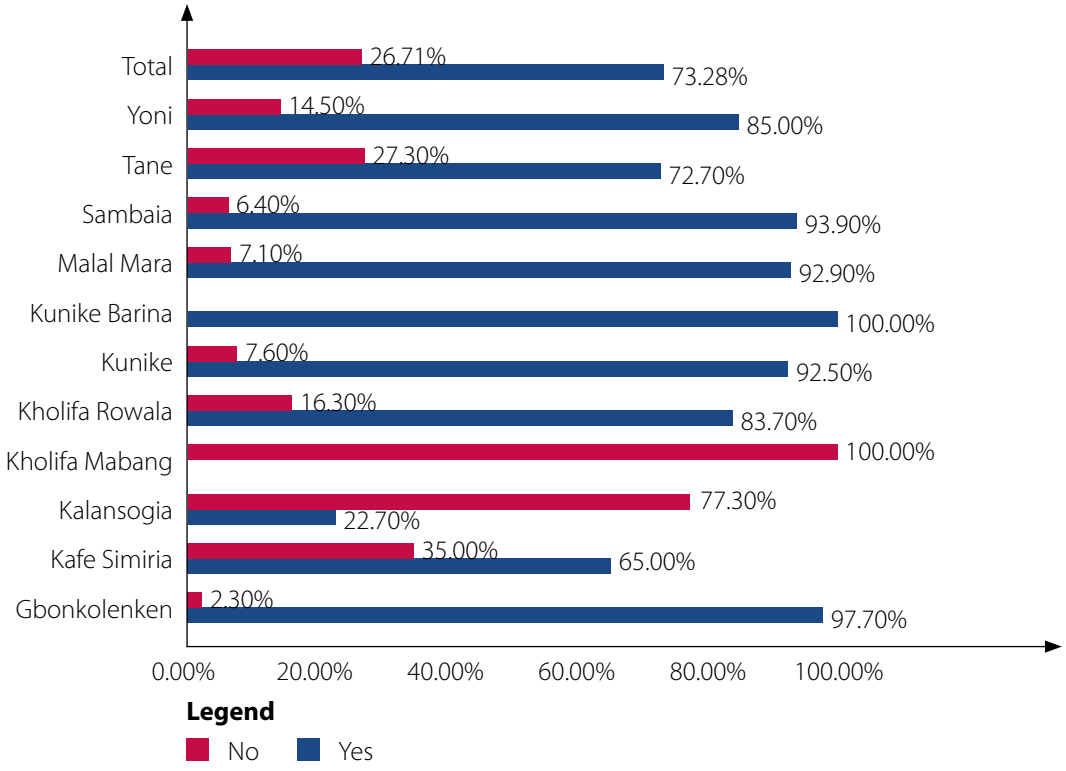


Figure 57. Use of fish from IVSs in chiefdoms.

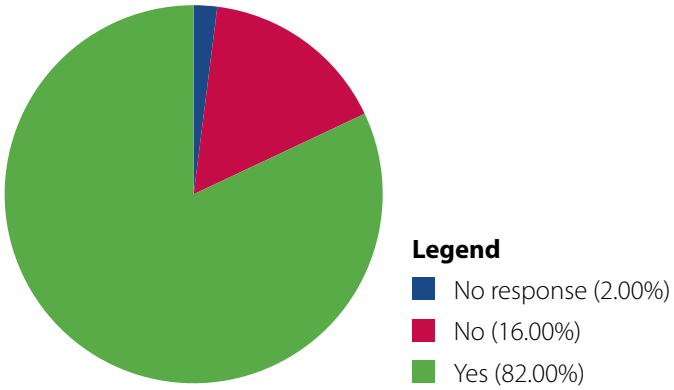


Figure 58. Respondents' perception of the use of fish from IVSs.

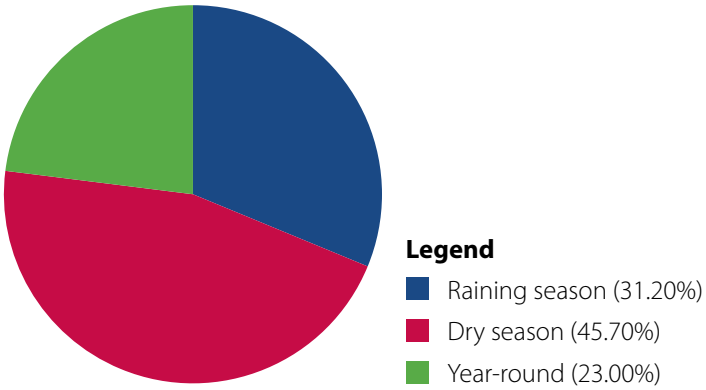


Figure 59. Time of year that fishing takes place in IVSs.

season (Figure 60). Respondents were asked whether it is possible for them to catch one particular species of fish when fishing in IVSs. Nearly a third (30%) said it was not possible, while 13% did not respond.

Crafts and gear used for fishing in IVSs

Gear and crafts that respondents used were seine nets, gill nets, current traps, valve net traps, triggered traps, wounding gear, cast nets, long lines, hook and line, and fixed bag nets. Other fishing methods include fencing and the use of trap ponds, which drained at the end of the raining season (Figure 61).

The most commonly used crafts or gear are set nets (42.2%) and hook and line (21.5%) followed by fencing across the rivers and streams (15.2%) and complete draining of IVSs (13.8%). Wounding gear (1.2%) and cast nets (0.8%) were the least used.

Communality of IVS fishing

Almost half (52.3%) of the people in Tonkolili District partake in communal fishing, which is a little higher than those (47.7%) who said they do not (Figure 62). In most of the communities in the district, the paramount chief[3] or section heads are responsible for

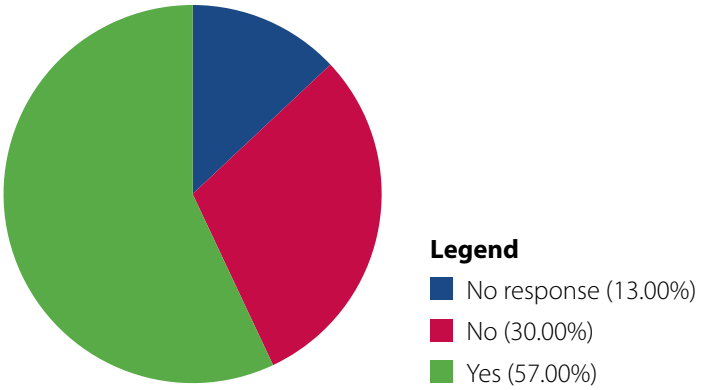


Figure 60. Seasonality of fishing in IVSs based on fish migratory patterns.

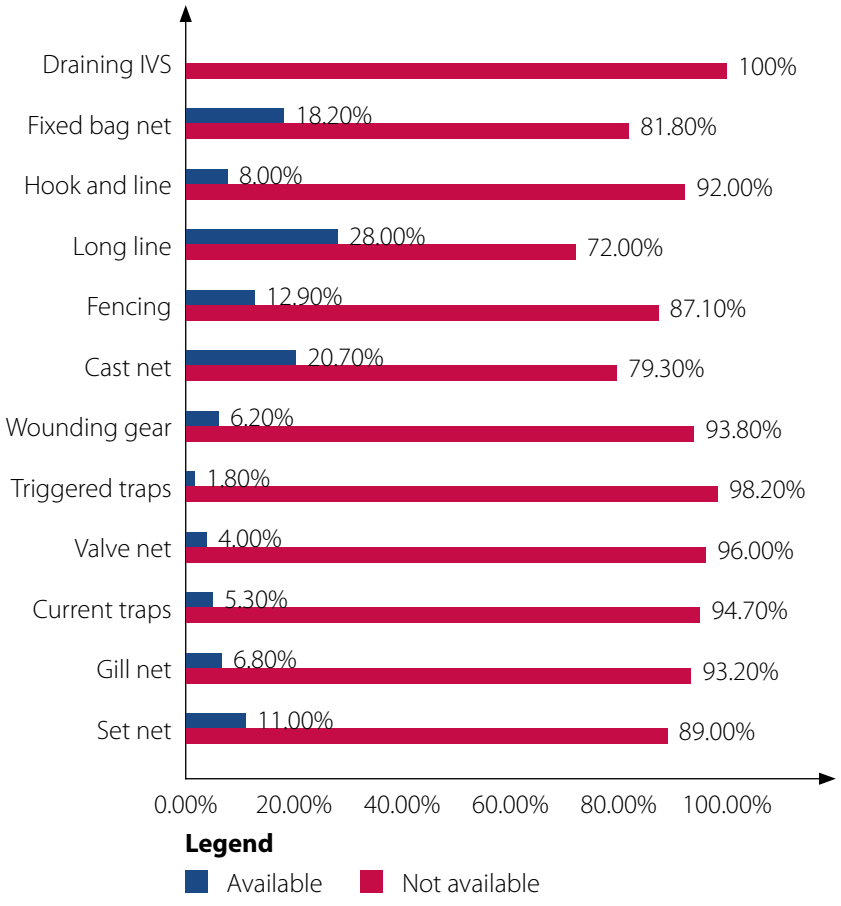


Figure 61. Crafts or gear used for fishing in IVSs.

declaring fishing time in community waters. Where this is not the case, groups of women from different households fish together in community waters or in IVSs belonging to the community.

Sales of fish caught in IVSs

Kholifa Mabang had the highest percentage of respondents (58.6%) who said that fish caught in IVSs are sold (Figure 63), likely because of the chiefdom's extensive floodplains, where fish are caught in abundance every year. Malal Mara ranked second (51.7%) among chiefdoms in Tonkolili, while Tane had the lowest (0.8.9%). Respondents who reported not selling fish caught in IVSs was also highest in Tane (91.1%), followed by Kafe Simira (88.1%) and Sambaia (87.2%). These figures show that the people of Tonkolili are well aware of capture fisheries activities in the district.

Profit from sales of IVS fish

Figure 64 shows data regarding whether or not respondents make money from selling fish caught in IVSs, while money made from fish sales on an annual basis is presented in Figure 65. A strong majority of the respondents (62.7%) said they do not make money from selling fish, while 23% said they do and 14.3% were not sure. The amount made yearly in the district ranged from SLL 100,000 to SLL 1,000,000 and above. Exactly 80% of respondents reported making more than SLL 1,000,000, followed by the 16% who made SLL 100,000–300,000. Those who made SLL 500,000–1,000,000 per year were last at just 1%.

Endemic fish species in IVSs

Respondents identified 12 freshwater fish species as endemic to IVSs in Tonkolili (Table 40). Fish belonging to the Aplocheilidae family are *Callopanchax huwaldi* (Berkenkamp and Etzel 1980), *Josiane panchax*

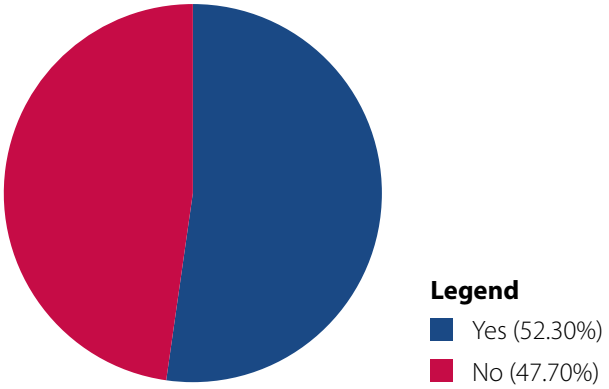


Figure 62. Communal fishing in IVSs.

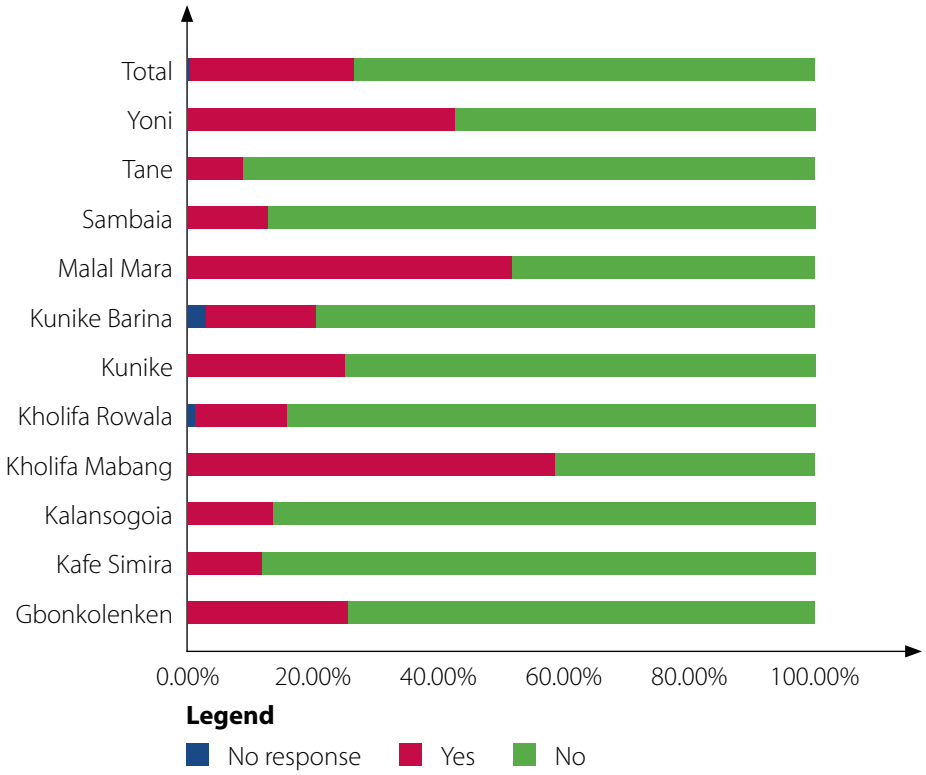


Figure 63. Sales of fish caught in IVSs.

(Berkenkamp and Etzel 1983), *Epiplatys josianae* (Berkenkamp and Etzel 1983), *Scriptaphyosemion chaytori* (Roloff 1971), *Chaytor kill fish, Scriptaphyosemion etzeli* (Berkenkamp 1979) and *Scriptaphyosemion fredrodi* (Vandersmissen, Etzel and Berkenkamp 1980), while those in the *Bagridae* family include *Notoglanidium thomasi* and the Cyprinidae family includes *Leptocypris taiaensis* (Howes and Teugels 1989). These species were also identified in different local languages in different chiefdoms. In contrast, Findlay (undated) identified 150 species from 34 families as endemic freshwater fish species in Sierra Leone. Further study is therefore necessary to identify some of the names that respondents supplied in local languages. This study should collect samples and make albums of the samples to compare them with the baseline, which will enable researchers to find out whether the fish are new to the environment.

Economically important food crops and aquatic plants from IVSs or the wild

Foraging for food crops in IVSs

The vast majority of respondents (84.8%) in Tonkolili District reported foraging for food crops in IVSs, while only 15.2% said they do not.

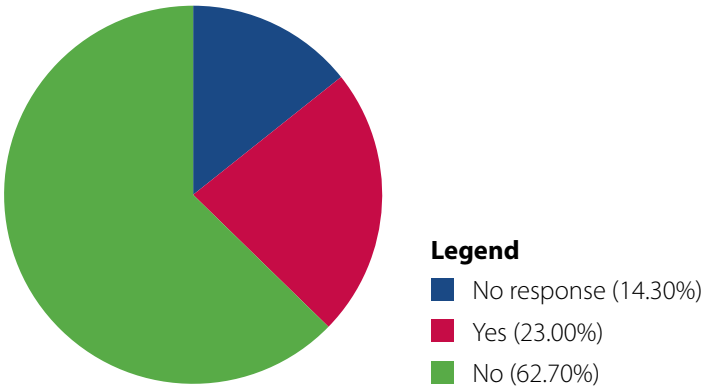


Figure 64. Money realized annually by respondents from fish sales.

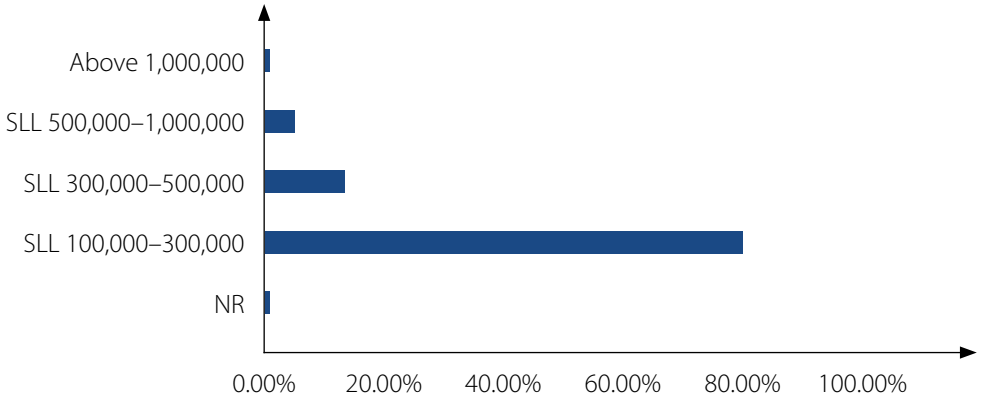


Figure 65. Distribution of money realized annually by respondents from fish sales.

Species name	Local names
Callopanchax huwaldi (Aplocheilidae)	Aborbor, Anthaica, Anthoka, Argboth, Bonakareh, Cothiel, Diron
Josiane panchax (Aplocheilidae)	Ankesella, Anpof, Anthoka, Efaka, Enkeshela, Enshemgbeh, Eromp
Epiplatys josianae (Aplocheilidae)	Ahpofe, Akontie, Ampofi, Anathala, Anbobo, Andiro Anfaka
Scriptaphyosemion chaytori (Aplocheilidae)	Adarie, Alor, Andera, Anglana, Ardera, Arfak, Borbor
Scriptaphyosemion etzeli (Aplocheilidae)	Adarie, Akonteh, Akonthe, Anborbor, Anfaka, Anrokrok
Scriptaphyosemion fredrodi (Aplocheilidae)	Abalan, Aborbor, Anborbor, Ankon, Anrokorrokor, Arbalan, Ardera
Notogianidium thomasi (Bagridae)	Ankam, Anshampa, Anthoka, Atocam, Bbeyaima, Bibare, Caria
Leptocypris taiaensis (Cyprinidae)	Agbane, Akana, Andiffy, Anakeria, Anpoffie, Anshamba
Prolabeo batesi (Cyprinidae)	Akuku, Andiro, Andorou, Angbantan, Ankerea, ankorkor, anpoffie
Raiamas scarciensis (Cyprinidae)	Acaria, Akutie, Anboka, Anthaca, Anthokan, Arkotie
Kribia leonensis (Eleotridae)	Adorok, Alawie, Amborbox, Antonthan, Antumbul, Bantam, Entintin
Malapterurus leonensis (Malapteruridae)	Anfetha, Angbbo, Ankam, Antumu, Borbor, Enfetha, Enfetha

Table 40. Freshwater fish species in IVSs of Tonkolili District.

Time of year for foraging in IVSs

Foraging for food crops in IVSs is a year-round activity in the district (Figure 66). Nearly half of the respondents (46.1%) reported foraging for food crops during the dry season (December–March) followed by the rainy season (30.4%). More than a fifth (22.2%) reported foraging year-round, while 1.3% do not forage during any of the seasons. The reason many respondents forage for plants in the dry season could be related to the fact that most edible wild plants ripen for harvest during this time. In the rainy season, respondents may only forage for vegetable crops.

Types of crops foraged

Different types of crop groups that respondents forage for in IVSs (Table 41) include vegetables, root crops, fruit crops, medicinal plants and spice plants (in order of importance). People in Tonkolili eat more vegetable crops than almost any other district in Sierra Leone.

Plate 15. Fish catching facilities in IVSs (left to right: fish trap and scoop net).

Purpose of foraging for food crops

Respondents gave many reasons that cause them to forage for food crops in IVSs (Figure 67). These include (a) to meet family needs (46.7%), (b) poverty (20%), (c) during periods of food shortage (11.4%) and (d) household nutrition needs (5.7%). Among the reasons for foraging in IVSs, meeting family needs ranked highest—which points to the fact that the majority of people in Tonkolili District are living below the poverty line—followed by poverty, while supplying household nutrition needs was the least common reason. Some respondents (15.9%) were unable to give any reasons for foraging in IVSs.

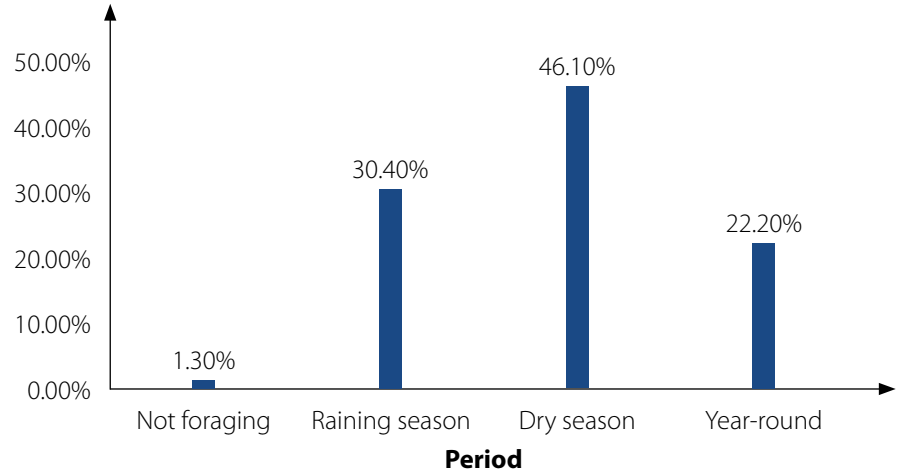


Figure 66. Time of year when respondents forage for food crops.

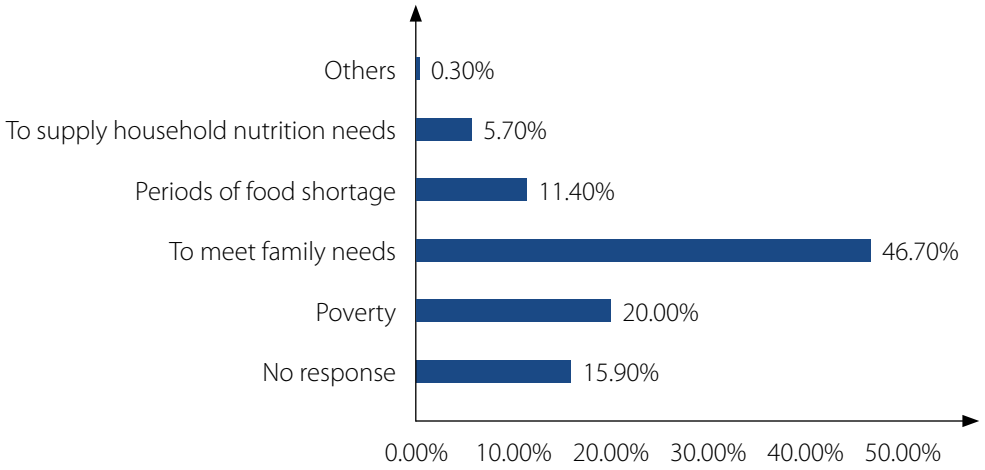


Figure 67. Reasons for foraging in IVSs.

Chiefdoms	No response	Fruit crops	Medicinal plants	Root crops	Spicy	Vegetables
Gbonkolenken	15.9%	20.5%	0.0%	27.3%	0.0%	36.4%
Kafe Simiria	20.0%	0.0%	2.5%	55.0%	0.0%	22.5%
Kalansogolia	36.4%	4.5%	0.0%	45.5%	0.0%	13.6%
Kholifa Maban	25.9%	22.2%	0.0%	25.9%	0.0%	25.9%
Kholifa Rowal	20.4%	21.4%	2.0%	19.4%	0.0%	36.7%
Kunike	5.4%	30.1%	3.2%	29.0%	0.0%	32.3%
Kunike Barina	0.0%	21.7%	4.3%	26.1%	0.0%	47.8%
Malal Mara	14.3%	0.0%	7.1%	10.7%	0.0%	67.9%
Sambaia	12.8%	12.8%	2.1%	68.1%	0.0%	4.3%
Tane	22.7%	13.6%	0.0%	11.4%	0.0%	52.3%
Yoni	10.7%	3.1%	1.5%	17.6%	1.5%	65.6%
Total	**14.9%**	**14.4%**	**2.0%**	**27.9%**	**0.3%**	**40.6%**

Table 41. Type of crops foraged, by chiefdom.

Awareness of the economic importance of aquatic plants in IVSs

More than three-quarters (80.2%) of respondents were aware of the availability of economically important aquatic plants. Only 19.2% were not aware,. Table 42 shows the various aquatic plants of economic importance that respondents usually use. Some of the plant names were given in the local language, while only three were identified by their scientific name. Improper naming may have been caused by field workers' lack of patience or lack of scientific knowledge.

Use of aquatic plants

Respondents were asked if they use aquatic plants for their personal use and/or for their animals. The percentage of those who used them was higher (68%) than those who do not (20%). Only 12% were not sure whether or not the plants are used.

Awareness of the nutritional values of aquatic plants

Regarding the nutritional value of aquatic plants, especially those in IVSs, the majority of respondents (76%) were aware of their nutritional value, while 14% were not . Ten percent gave no response.

Game hunting in the wild and IVSs

Hunting for game in IVSs and their catchments is a common phenomenon in Tonkolili. Although the proportion of respondents who said they do not hunt in IVSs and their catchments was higher (53.9%) than those who do (39.4%), the latter is significant enough to conclude that hunting for game in the district is common.

Aquatic plants endemic to IVSs	Frequency	Percentage
(No response)	469	78.2
Akara	1	0.2
Azolla nilotica	33	5.5
Azolla pinnata	31	5.2
Ebarreh	2	0.3
Ebinyonbat	1	0.2
Ekai	1	0.2
Ennan	2	0.3
Gbinhonbat	2	0.3
Kalolem	3	0.5
Kalonlon	2	0.3
Kaporeh	1	0.2
Ipomea reptans	19	3.2
Kosay kosay	17	2.8
Kossi	1	0.2
Magbeth	3	0.5
Nana	4	0.7
(Not available)	7	1.2
Umbondor	1	0.2
Total	**600**	**100**

Table 42. Aquatic plants of economic importance in IVSs.

Plate 16. Duckweed in an IVS.

Types of game hunted

Commonly hunted game in the district include cane rats, bats, antelope, monkeys, bush pigs, squirrels, rabbits, bush cows, deer, porcupine, bush fowl and snakes. Cane rats (58.5%), squirrels (45.2%) and monkeys (41.1%) were hunted the most in the district, while bats (1.5%) and bush pigs (1.4%) were the least hunted.

Hunting period

Hunting for game in Tonkolili District is a year-round activity (Figure 68). The amount of respondents who hunt game year-round (23.6%) surpasses those who hunt only in the dry season (5%) or in the rainy season (11.7%). The majority was unsure whether hunting is done at any period of the year.

Reasons for hunting game

Tonkolili inhabitants hunt game for many reasons (Figure 69). These include pest control, supplying nutrition for the household, augmenting an insufficient supply of cultivated crops, meeting dire needs of the family, and poverty. A slight majority of respondents (50.4%) said that they hunt as a means of controlling mammalian pests in IVSs, while meeting family needs (40.3%) and supplying household nutrition needs (29.8%) were the second- and third-most common reasons, respectively. Poverty (13%) and augmentation of shortfall as a result of insufficient supply from cultivated crops (8%) were the least common reasons.

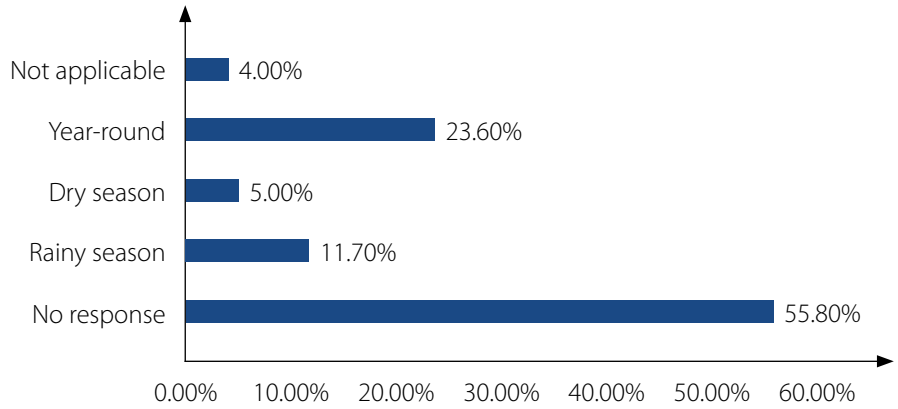


Figure 68. Time of year game is hunted.

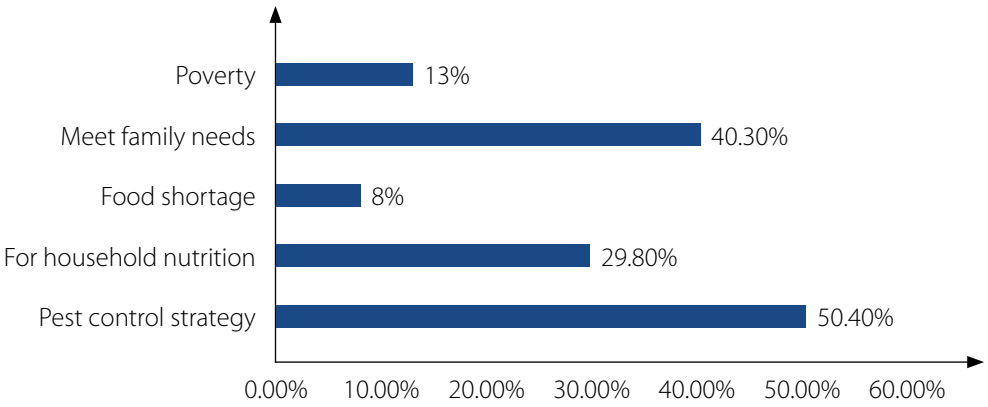


Figure 69. Reasons for hunting game.

Conclusions and recommendations

Conclusions

This study aimed to analyze the actual use, constraints on the use and the agro-potential of IVSs in Tonkolili District. Through interviews and limited field testing, it was possible to obtain detailed information regarding socioeconomic aspects and food production systems, as well as a rough assessment of physical properties such as soil quality and inundation period for each targeted IVS in all 11 chiefdoms in the district.

Key conclusions of the study include the following:

- IVSs are one of the most important ecological resources in Sierra Leone. They provide many economic benefits to associated communities, including crop farming, fish farming, foraging and hunting.
- Among the three predominant farming ecologies (upland, IVS and *boliland*), upland and IVS are the most used.
- Because of the ability of IVS soils to maintain water availability for a longer period than upland soils, as well as higher yields of rice than in the upland, IVSs offer more benefits and prospects for food production.
- The prevalent system of land tenure is communal ownership, where land is always owned by the extended family, never exclusively by an individual. This ownership ensures equal rights for all adult men of an extended family and unrestricted access for unmarried women, paving the way for access to land by the majority of members in the community.
- Leasing or outright selling IVS land is rare. Acquiring it through nonfamily members or by outsiders occurs through granting usage rights with royalty payments.
- Because land is communally owned, IVS communities have adequate access for their farming needs. However, they are limited in their access to adequate land area for farming activities, since typical farmland area is only 1–2 ha. Inadequate farmland and a lack of access to financial resources are linked to low input-low output subsistence farming, with low annual income levels and very little food crop surplus after meeting household consumption needs.
- Farming is the predominant economic activity in Tonkolili District. Many farmers are engaged in subsistence farming of rice, cassava, yams, sweet potatoes, maize, millet and a variety of local fruits and vegetables as staple food crops. This underscores the importance of developing the farming sector to raise income levels in the district.
- Bank loans are hard to come by for subsistence farming activities. Lack of collateral and social status, as well as high interest rates, are the main constraints preventing subsistence farmers from obtaining formal bank loans. Consequently, farmers turn to informal credit sources or personal savings.
- The government and its partners are trying to develop and promote the use of IVSs, largely for rice production; however, these efforts have not resulted in rice self-sufficiency.
- From a hydrological standpoint, there is potential to implement interventions to intensify the development and use of IVSs for food production, especially in areas having perennial swamps or swamps with water for up to 8–9 months. A significant proportion of IVSs falls into this water residency category.
- Perennial IVSs support two to three rice crops per year, while nonperennial ones are limited to one to two crops during the rainy season and vegetable farming during the dry season. Farmers tend to grow high-yield varieties of rice rather than traditional varieties to maximize the number of crops on small farms.
- In general, IVSs in the northern and eastern parts of Tonkolili District tend to have more favorable water regimes for rice cultivation and aquaculture than those in the southern and western chiefdoms.

- The study showed a clear gender-based division of labor in crop farming. Men are actively involved in labor-intensive activities, such as brushing, felling, land clearing and plowing fields, while women are usually involved as integral members of the household labor force. Women who traditionally produced vegetables for household consumption are now cultivating cash crops for the market because of increasing cash needs arising from the massive devaluation of the national currency in the past 10 years and the resulting increases in the prices of essential commodities and services.

- Women meet their responsibility to fund social and cultural events and children's education by cultivating cash crops for the market.

- There is high, unused agro-potential in the valleys, especially during the dry season, as a result of the undeveloped status of the IVSs and lack of water control structures in the majority of IVSs.

- Agricultural services provided to IVS communities by the state are limited to improved seed supply and technical advice, while farmers' limited access to credit remains unaddressed.

- The inability to meet the labor requirements because of current trends in urban migration as well as the high cost of constructing water control structures are the two primary constraints keeping IVS development and use from realizing their potential.

- Market access for farm produce is not a constraint. The majority of farmers claimed that they have access to markets, which is a *sine qua non* to sell their produce and improve farming systems to meet commercial need.

- A significant proportion of farmers belong to farmers groups or associations, focusing on crop processing, savings and credit, and procuring farm inputs.

- Over 70% of assessed IVSs have adequate rooting depth (11–30 cm) for rice cultivation and topography, water availability and residency. Soil types show potential to develop fishponds.

- Considering the significant extent of IVS availability in the district (54,650 ha), with rice as the primary cultivated crop, there is great potential for integrated rice-fish farming to increase income as well as food and nutritional security. If 10% of the IVSs were developed for rice-fish farming, over 1450 t of fish could be produced, which would feed more than half of the population in the district at a consumption rate of 10 kg per capita.

- Farmers practice integrated crop farming with livestock rearing, as well as wet season rice cultivation combined with dry season vegetable production. Farmers are also aware of the benefits of integrated farming systems, so the concept of integrating farming systems is not alien to the communities. This awareness facilitates the introduction of integrated aquaculture-agriculture and integrated aquaculture-horticultural crop practices into farming systems. The integration of fish farming into local production systems has yet to become common.

- In Sierra Leone, 90% of fishponds are located in IVSs in Tonkolili District, which were once operational but now are mostly not operating. The apparent neglect of fish farming suggests urgent interventions are required to revitalize the fish farming industry with required support services.

- As with crop farming, the scale of fish farming operations is generally at the subsistence level, which affects the size of fish farms and their stocking density and consequently lowers the yield coming from such farms. Subsistence fish farming suffers from low growth performance and poor yields as a result of the use of genetically poor fish seed, poor feed addition and farmers' lack of knowledge regarding good management practices.

- Farmers have the potential to increase fish yields by using appropriate fish feed. This is possible with proper access to fish feed ingredients, such as rice bran, cassava and palm kernel, to prepare farm-made fish feed. Farmers also have access to fish waste in local markets to use as a source of fishmeal. Yields can also be increased by using good management practices.

- As an aquaculture species, tilapia fetches a reasonable market price of between SLL 5000 and 15,000, depending on the size. The main constraints affecting fish marketing in Tonkolili include irregular fish supply, the fact that people have become used to game hunting in IVSs rather than fish farming, exploitation of buyers by middlemen, high transportation cost and a poor road network.

- Fish availability was the leading factor affecting respondents' preference for fish, while price was the least common consideration. This suggests that increasing fish production from aquaculture and capture fisheries will increase access to fresh fish for households.

- Use of wild fish in IVSs occurs using several methods, including set nets, hook and line, fencing, and complete draining of IVSs. Fishing for wild fish in IVS areas takes place throughout the district, occurring more often during the dry season than at any other time. In almost all IVSs, fishing takes place in the rainy season, especially in May and June, when fish come to breed in the floodplain. Fishing takes place during the dry season in November, December and January, when water in the IVSs has receded and certain wild fish are more accessible.

- IVS communities are aware of the importance of managing wild fishstocks, as they enact temporary fishing bans in locations where fishstocks need time to replenish themselves.

- People forage for food, including aquatic plants, in IVSs. People are aware of the availability of aquatic plants of economic importance in IVSs, as well as the nutritive values of the plants.

Recommendations

1. The predominance of agriculture in the local economy underscores the need to develop the sector if there is to be any serious attempt to alleviate poverty and ensure food and nutritional security in the district.

2. In line with the above recommendation, the government (with assistance from potential donors) should develop water control structures with irrigation channels in IVSs. These actions will help to realize the full potential of food production capacity by enabling double-cropping of rice in addition to alternating the cultivation of rice and vegetables.

3. Pervasive poverty in the form of low income levels accentuates the need for financial assistance as a necessity for agricultural development. In the case of IVS development for either crop production or aquaculture, assistance is required to access financial resources in the form of startup grants or soft loans. These financial resources can help enable the construction of ponds or drainage structures as well as the procurement of initial inputs (seed, agro-chemicals, fingerlings, etc.).

4. One of the most significant constraints on crop production and aquaculture in IVSs is the small size of these areas and a lack of access to inputs such as lime, fertilizer, quality crop seeds, fish fingerlings, fish feed and financial capital. Consequently, farmers are limited to small-scale subsistence farming. Maximizing yields is paramount and can be aided by using integrated farming systems (e.g. rice with fish or fish with vegetables), linking farmers to financial resources to enable them to acquire capital and inputs, and training farmers in good management practices. The following relate to the above recommendation:
    - Conducting a sustainable livelihoods analysis will help to (a) establish some of the livelihood aspects of farming systems in IVSs, which would resolve the outstanding questions regarding the socioeconomic status of the IVS farmers, (b) establish significant indicators relating to the value of integrating agriculture farming systems with aquaculture systems and fish production, and (c) identify interventions to reduce vulnerability in the livelihoods of poor communities.
    - Because most farmers belong to farmers' groups, it is important to strengthen cohesive groups by training them in group organization and resource mobilization. These steps will help address high labor requirements and labor costs incurred by sharing labor within the group.
    - Cohesive farmers groups can become the nuclei of agricultural business centers, which can be registered with the CBs and FSAs that have been established in the district under the supervision of IFAD. Registration with CBs and FSAs is expected to promote savings and improve access to loans.

- In line with the above two recommendations, it is important to work with existing groups. Groups thrive in rural communities because they are already cohesive and established, so it is unlikely that groups formed by outsiders will thrive.
- Because land is always owned by the extended families and never exclusively by an individual, farming systems need to be improved by basing them on household ownership rather than community group ownership.
- Because the majority of farmers belong to some form of farmers group that is engaged in activities and services, such as crop processing, procurement of farm inputs, and savings and credit, there is potential to implement further interventions designed to encourage farmers groups to step into value chain services (e.g. input supplies as an agribusiness). One such example is fish seed and vegetable seed supply.
- The low growth performance and poor yield reported in pond aquaculture are the result of using genetically deteriorated fish seed and poor addition of fish feed. As such, it is important to strengthen quality fish seed and feed supply.
- Decentralized vegetable seed and fish seed supply networks should be promoted among existing cohesive farmers' groups based on the cluster farmer model 4.
- Promoting farm-made fish feed with ingredients accessible to farmers, such as rice bran, cassava, palm kernel and fish wastes, is necessary until fish production levels are sufficiently high to justify small-scale commercial fish feed mills.
- It is important to build farmers' capacity of affordable good management practices to improve yields of rice, vegetables and fish from a given plot.

5. To enable women to benefit from IVS interventions, the following measures are recommended:
   - Although there is acceptance in all chiefdoms of the district that women can have access to land for their various needs, many women caution that there is a tendency for men to take over development initiatives when they prove beneficial. For this reason, there should be a documented agreement with land owning families that women/women's groups who undertake development of an IVS plot (either for crop cultivation or aquaculture) will have inalienable rights to that plot.
   - Women should be organized into production groups to engage in value chain interventions such as seed supply and extension services.
   - Women typically do not have the required labor or capital for IVS development, so it is advisable to provide seed money or soft loans to facilitate initial development work. Access to credit should be facilitated by linking the women's production groups with reliable credit sources (e.g. CBs and FSAs, which have been established in several chiefdoms of the district).
   - Women's production groups should be assisted in marketing their produce to their best advantage, thereby encouraging women to continue IVS use.

6. A multifactor ranking of IVSs should be developed, taking into account physical characteristics, socioeconomic characteristics and potential beneficiaries' levels of fish culture experience. This will be useful when selecting IVSs for interventions.

7. The assessment revealed the importance of water management in IVSs used for agriculture and aquaculture. Problems with water management were reported as important constraints on the use of IVSs. It would be beneficial to develop a fund within MAFFS to improve water management in IVSs. IVSs suitable for building water retention bunds along contour lines or dam ponds should be identified and developed to retain water. For example, a sluice ensures water control in the case of high water levels. In other IVSs, irrigation systems with wells and treadle pumps should be installed to facilitate irrigation during the dry season.

8. The communities are aware of fishstock conservation methods in IVSs. The heads of the extended families occasionally ban fishing in certain swamps for specified periods to prevent overfishing and allow natural fishstocks to replenish. Interventions are needed to capitalize on this awareness to implement habitat enhancement and fish refuge techniques, since these actions have the potential to increase wild fisheries and rice field fisheries in IVSs.

9. Eighteen fish species have been identified as endemic freshwater fish species in Sierra Leone. At least eight of them are targeted in capture fisheries in Tonkolili District. Moreover, the use of nonselective fishing gear targeting all sizes of fish, such as fences or gill nets with small mesh sizes, is concerning with regard to fish resource conservation. Most of the fishing that takes place in the floodplains during the rainy season may have a negative impact on the breeding populations because they may be targeted by the nonselective fishing gear. It is necessary to revisit regulations relevant to inland fisheries and undertake a study to update the inventory of freshwater inland fish species and floodplain dynamics in the district.

10. People's preference for fish is governed by the availability of the fish more than any other factor. Therefore, increasing the production of fish from aquaculture and capture fisheries will increase households' access to fresh fish.

11. Creating markets and improving existing marketing channels and linkages are both crucial to encourage farmers to take up crop farming and fish farming as an agribusiness. Government and other development partners and private investors could help develop an effective market for the sales and disposal of fish and fish products.

12. There is a need to investigate the long-term sustainability of IVS use in light of farmers' experiences with declining crop yields because of the continuous use of IVSs.

13. Academic and research institutions, such as Njala and SLARI, should develop institute-farmer partnerships to formulate research agendas aiming to work on issues surrounding sustainable food production systems.

14. The extension services and outreach unit of both MAFFS and MFMR need to be strengthened for effective extension delivery.

15. Currently, there is no extension arm in the MFMR, nor an immediate plan to create one. The ministry should work in partnership with the extension arm of MAFFS to deliver extension services for aquaculture farmers.

16. MAFFS and the MFMR should identify previously trained and better-performing agriculture and aquaculture farmers to work in partnership with the ministries for extension delivery.

17. MAFFS and the MFMR should jointly prepare a directory of these better-performing farmers and make available the directory of NGOs and donor-sponsored development projects as an incentive to these farmers. This can help use the capacities of these farmers on a voluntary or paid basis, enabling the farmers to engage in extension work and training other farmers in their own communities as well as others.

18. Extension and training should not be limited only to strengthening knowledge and skills to change the attitudes and behaviors of poor households, which would enable them to become primary producers (e.g. crop and fish farmers), but should also extend to offering opportunities for them to become secondary producers (e.g. processors and traders).

19. It is necessary to adopt extension approaches that empower farmers with greater planning, monitoring and decision-making abilities. This approach should be incorporated into extension and technology development with strong management tools for farmers.

20. Farmers have a wealth of indigenous knowledge regarding farming systems and uses for and of IVSs, including constraints on them. This knowledge should be studied and documented to promote useful indigenous knowledge as well as to discourage inaccurate or harmful indigenous beliefs. This documented indigenous knowledge should be used in extension services and made available for the planning and improvement of IVS development projects and programs.

21. A reasonable amount of work has been done to characterize IVSs in Sierra Leone, and the government and its partners have expended considerable effort on the development and use of IVS. These efforts, however, have not resulted in sustainability and self-sufficiency in food production. In light of this, the following recommendations are presented:
    - To ensure effective IVS use, farmers should be supported by MAFFS and the MFMR, together with development organizations, to improve knowledge of cultivation methods, such as fish farming and IVS management.
    - Poverty-focused interventions designed to enable the poor to enter into aquaculture should be based on sound poverty alleviation strategies. Sound poverty alleviation strategies can only be developed once it is known who is poor, why they are poor and how they are poor. A sustainable livelihoods analysis is required to achieve this and enable opportunities for poor people to enter into food production, including aquaculture.
    - Interventions should focus on identifying which opportunities can be made available for the poor to enter into food production, including aquaculture, and how those opportunities can be realized. Opportunities should be diversified to include a spectrum of options for diverse situations, from cases of individual ownership to communal aquatic resources. Options should also minimize risk and optimize integration into farmers' livelihood activities.
    - When promoting opportunities for the poor to enter into food production, the standard approach should be to first look at what is already in the community, which methods are effective for promoting food production activities, which aspects need improvements, and opportunities for integration with other livelihoods.
    - For all opportunities provided, there should be a special emphasis on the particular needs of women. Moreover, enhanced awareness regarding the nutritional value of food should be integrated within interventions to enhance the nutrition security of the poor, especially women and children.

Notes

[1] Secondary bush refers to forest regrowth after a plot has been cleared, cropped and left to lie fallow with the aim of restoring soil fertility.

[2] Freehold property can be defined as any estate that is "free from hold" of any entity besides the owner. Hence, the owner of such an estate enjoys free ownership for perpetuity and can use the land for any purposes whatsoever in accordance with local regulations. Sale of a freehold property does not require consent from the state and hence requires less paperwork, thus, making it more expensive than leasehold property.

[3] A chiefdom is divided into several sections. A section is divided into several villages. The paramount chief is the head of a chiefdom, while a section head is the head of a village.

[4] Formation of farmers into groups for collective actions such as sharing labor, access to credit and training, and pool produce to access a better market.

References

[ABC] Agriculture Business Center. 1992. Agricultural master plan in Sierra Leone Freetown, Sierra Leone: Ministry of Agriculture.

Abu MB, Hilton-Lahai AH and Abifarin AO. 1987. Iron toxicity survey in Sierra Leone. West Africa Rice Development Association (WARDA). Technical Newsletter. 8–9.

[ACP] African, Caribbean and Pacific Fish II. 2013. A comprehensive aquaculture baseline study, Sierra Leone. Final Technical Report (SLE 107R04A).

Adams WM. 1993. Indigenous use of wetlands and sustainable development in West Africa. *The Geographical Journal* 59:209–18.

Baggie I, Lamin AS and Lahai MT. 1986. Inland valley research and development in Sierra Leone. Cotonou, Benin: Africa Rice Center.

Chapman LJ, Balirwa J, Bugenyi FWB, Chapman C and Crisman TL. 2001. Wetlands of East Africa: Biodiversity, exploitation and policy perspectives. In Gopal B, Junk WJ and Davis JA, eds. *Biodiversity in Wetlands: Assessment, function and conservation***.** Leiden, the Netherlands: Backuys. 101–32.

[CIFA] Committee for Inland Fisheries of Africa. 2000. Africa regional aquaculture review: Proceedings of a workshop held in Accra, Ghana, 22–24 September 1999. A report prepared for the Fisheries Department Group (RAFI) of the FAO Regional Office for Africa.

COFREPECHE. 2013. A comprehensive aquaculture baseline study: Sierra Leone. Final Technical Report. Project ref. N° WA-1.2-B1. Strengthening fisheries management in ACP countries. Accessed on 12 July 2016. http://acpfish2-eu.org/uploads/projects/id309/WA-1.2-B1%20FTR.pdf

Dingle WB. 1984. Swamp rice development in Sierra Leone: Observations and recommendations. FAO Interim Report (SIL/82/006). Rome: FAO.

[EPA] Environment Protection Agency. 2015. Sierra Leone state of the marine environment report 2015. Freetown, Sierra Leone: EPA.

[FAO] Food and Agriculture Organization of the United Nations. 1980. Agro-ecological atlas of Sierra Leone: A survey and appraisal of climate and crop resources, based on the work of J. Kowal, in collaboration with the Agro-Climatological Section and Staff of the Land Resources Survey Project. AG:DP/SIL/73/002, TR 5.

[FAO] Food and Agriculture Organization. 2000. National aquaculture sector overview: Sierra Leone. Accessed on 25 February 2016. http://www.fao.org/fishery/countrysector/naso_sierraleone/en

[FAO] Food and Agriculture Organization. 2003. Agricultural sector review and formulation of agricultural development strategy. TCP/SIL/2904 (A).

[GoSL] Government of Sierra Leone. 1932. Report of the Department of Agriculture. Freetown, Sierra Leone: GoSL.

[GoSL] Government of Sierra Leone. 1956. Report of the Department of Agriculture. Freetown, Sierra Leone: GoSL.

[GoSL] Government of Sierra Leone. 1961. White paper on natural resources policy. Freetown, Sierra Leone: GoSL.

[GoSL] Government of Sierra Leone. 1974. National development plan 1974/75–1978/79. Freetown, Sierra Leone: GoSL.

[GoSL] Government of Sierra Leone. 2005. Support for New Partnership for Africa's Development (NEPAD)-Comprehensive Africa Agricultural Development Program (CAADP) Implementation.

[GoSL]. 2009. National rice development strategy. Paper prepared for the Coalition of African Rice Development (CARD).

Green L. 1966. The system of land tenure in Sierra Leone. [MA thesis] Durham University, United Kingdom.

Haque I. 1977. Iron toxicity in Sierra Leone. *International Rice Research Newsletter* 2(1):10.

Lamin AS, Kandeh M, Jalloh A, Dixon BA, Massaquoi BA and Rashid-Noah AB. 1999. State of the art at the national level for inland valley development in Sierra Leone. Final report. Consortium for the Sustainable Use of the Inland Valley Agro-ecosystems in Sub-Saharan Africa.

[MFMR] Ministry of Fisheries and Marine Resources. 2003. Fisheries policy document. Freetown, Sierra Leone: GoSL.

[MOHS] Ministry of Health and Sanitation. 2002. Statistical information sheet. Freetown, Sierra Leone: MOHS.

Moyo S and Foray M. 2009. UNDP scoping mission report: Key land tenure issues and reform processes in Sierra Leone. Report commissioned for the Ministry of Land, Country Planning and the Environment. Freetown, Sierra Leone: UNDP.

[NCU] National Coordinating Unit. 1999. Five-year strategic plan for development of IVS systems in Sierra Leone. Freetown, Sierra Leone: NCU.

Odell RT, Dijkerman C, van Vuure W and Melsted S. 1974. Characteristics, classification and adaptation of soils in selected areas in Sierra Leone in West Africa. Bulletin 748, Agricultural Experiment Station, College of Agriculture, University of Illinois at Urbana-Champaign.

Rashid-Noah AB. 1995. Survey and development of lowlands for rice production. WARDA Training Guide 4, 9-10, Bouaké, WARDA.

Rashid-Noah AB. 1999. The state of the art in lowland research and development undertaken by Njala University College Staff: Hydrology and water management**.** In Lamin AS, Kandeh M, Jalloh A, Dixon BA, Massaquoi BA and Rashid-Noah AB, eds. State of the art at the national level for inland valley development in Sierra Leone. Final report. Consortium for the Sustainable Use of the Inland Valley Agro-ecosystems in Sub-Saharan Africa.

Rashid-Noah AB, Fattah M, Tarawallie H, Barber GM and Yillah AB. 2009. Inland valley swamp inventorization desk study. Second progress report**.** Freetown, Sierra Leone: FAO.

Renner-Thomas A. 2010. *Land Tenure in Sierra Leone: The Law, Dualism and the making of a Land Policy*. p 410. UK: AuthorHouse.

[RRS] Rice Research Station. 1985. Annual report. Rokupr, Sierra Leone.

Roberts N. 1988**.** Dambosin development: Management of a fragile ecological resource. *Journal of Biogeography* 15:141–48.

Rodenburg J, Both J, Hoitkonig I, van Koppen K, Sinsin B, van Molo P and Kiopo P. 2012. Land use and biodiversity in unprotected landscapes: The case of non-cultivated plant use and management by rural communities in Benin and Togo. *Society and Natural Resources* 25(12):1221–40.

Scoones I. 1991. Wetlands in dry lands: Key resources for agricultural and pastoral production in Africa. *Ambio* 20:366–71.

[SATS] Sierra Agricultural and Technical Services. 1996. Inland valley swamp development study. Annex 4: Agronomic factors.

[SLARI] Sierra Leone Agricultural Research Institute. 2011. Sierra Leone Agricultural Research Institute, Strategic Plan 2012–2021.

Spencer DSC, Deen S and Wilson C. 2009. Economics of rice production in Sierra Leone: Report of a survey in three northern districts. New York: Soros Economic Development Fund. http://www.eds-sl.com/docs/

Turner RK, van den Bergh JCJM, Sodergvist T, Barendregt A, van der Straden J, Maltby E, van Lerland CJ and New MG. 2000. Ecological-economic analysis of wetlands. Scientific integration for management and policy. *Ecological Economics* 35:7–23.

[UNDP and FAO] United Nations Development Programme and the Food and Agriculture Organization. 1979. Land in Sierra Leone: A reconnaissance survey and evaluation for agriculture. Land resources survey, Sierra Leone. Technical Report 1.

[UNDP and FAO] United Nations Development Programme and the Food and Agriculture Organization. 1980. Agro-ecological atlas of Sierra Leone: A survey and appraisal of climate and crop resources. Land resources survey, Sierra Leone. Technical Report 5.

Wopereis MCS, Defoer T, Idinoba P, Diack S and Dugué MJ. 2009. Participatory Learning and Action Research (PLAR) for Integrated Rice Management (IRM) in inland valleys of sub-saharan africa: Technical Manual. AfricaRice. Accessed on 09 October2017. http://www.africarice.org/warda/guide-plar-tech.asp

World Bank. 2015. World Bank Data. Accessed on 21 September 2017. https://data.worldbank.org/indicator/SP.DYN.CONM.ZS

WorldFish. 2016. Report of the aquaculture assessment studies for Tonkolili and Bombali districts. Freetown, Sierra Leone: WorldFish. (unpublished).

Appendix A. Results of the IVS physical assessment presented by chiefdom

Chiefdom		By foot	By motorbike or bicycle	By motor vehicle	Total
Gbonkolenken	Frequency (f)	44	0	0	44
	% of total	7.30%	0.00%	0.00%	7.30%
Kafe Simira	f	40	1	0	41
	%	6.70%	0.20%	0.00%	6.80%
Kalansogoia	f	22	0	0	22
	%	3.70%	0.00%	0.00%	3.70%
Kholifa Rowala	f	89	4	6	99
	%	14.80%	0.70%	1.00%	16.60%
Kholifa Mabang	f	20	4	1	25
	%	3.30%	0.70%	0.20%	4.20%
Kunike	f	88	0	1	90
	%	14.90%	0.00%	0.20%	15.0%
Kunike Barina	f	26	2	0	28
	%	4.30%	0.30%	0.00%	4.70%
Malal Mara	f	26	1	0	28
	%	4.50%	0.20%	0.00%	4.70%
Sambaia	f	43	0	4	47
	%	7.20%	0.00%	0.70%	7.90%
Tane	f	42	1	3	46
	%	7.00%	0.20%	0.50%	7.70%
Yoni	f	115	13	1	129
	%	19.20%	2.20%	0.20%	21.50%
Total	**f**	**557**	**26**	**16**	**599**
	%	**93.00%**	**4.30%**	**2.70%**	**100.00%**

Table A1. Frequency and percentage distribution of ways of accessing the IVSs.

Chiefdom		<1 acre	1–3 acres	3.5–4 acres	4.5–5 acres	5.5–6 acres	6.5–7 acres	7.5–8 acres	>7 acres	Total
Gbonkolenken	Frequency (f)	3	20	16	4	0	0	0	1	44
	% of total	0.50%	3.30%	2.70%	0.70%	0.00%	0.00%	0.00%	0.20%	7.30%
Kafe Simira	f	15	24	1	1	0	0	0	0	41
	%	2.50%	4.00%	0.20%	0.20%	0.00%	0.00%	0.00%	0.00%	6.80%
Kalansogoia	f	12	9	1	0	0	0	0	0	22
	%	2.00%	1.50%	0.20%	0.00%	0.00%	0.00%	0.00%	0.00%	3.70%
Kholifa Rowalla	f	22	54	23	0	0	0	0	0	99
	%	3.70%	9.00%	3.90%	0.00%	0.00%	0.00%	0.00%	0.00%	16.60%
Kholifa Mabang	f	1	17	5	1	1	0	0	0	25
	%	0.20%	2.80%	0.80%	0.20%	0.20%	0.00%	0.00%	0.00%	4.20%
Kunike	f	0	37	29	8	11	1	1	3	90
	%	0.00%	6.20%	4.90%	1.30%	1.80%	0.20%	0.20%	0.50%	14.90%
Kunike Barina	f	2	8	7	7	3	1	0	0	28
	%	0.30%	1.30%	1.20%	1.20%	0.50%	0.20%	0.00%	0.00%	4.70%
Malal Mara	f	3	12	8	3	0	0	0	2	28
	%	0.50%	2.00%	1.40%	0.50%	0.00%	0.00%	0.00%	0.40%	4.70%
Sambaia	f	12	26	6	1	0	0	0	2	47
	%	2.00%	4,40%	1.00%	0.20%	0.00%	0.00%	0.00%	0.30%	7.90%
Tane	f	8	22	9	5	1	0	0	1	46
	%	1.30%	3.70%	1.50%	0.80%	0.20%	0.00%	0.00%	0.20%	7.70%
Yoni	f	17	79	16	6	1	2	0	8	129
	%	2.80%	13.20%	2.70%	1.00%	0.20%	0.30%	0.00%	1.30%	21.50%
Total	**f**	**95**	**308**	**121**	**36**	**17**	**4**	**1**	**17**	**599**
	%	**15.90%**	**51.40%**	**20.20%**	**6.00%**	**2.80%**	**0.70%**	**0.20%**	**2.80%**	**100.00%**

Table A2. Distribution of surface areas of the IVSs.

Chiefdom		Flat	Steep slope	Undulating	Uniform gentle slope	Total
Gbonkolenken	Frequency (f)	17	5	0	22	44
	% of total	38.60%	11.40%	0.00%	50.00%	100.00%
Kafe Simira	f	38	0	0	3	41
	%	92.70%	0.00%	0.00%	7.30%	100.00%
Kalansogoia	f	21	0	0	1	22
	%	95.50%	0.00%	0.00%	4.50%	100.00%
Kholifa Rowalla	f	85	0	0	14	99
	%	91.90%	0.00%	0.00%	8.20%	100.00%
Kholifa Mabang	f	19	4	0	2	25
	%	76.00%	16.00%	0.00%	8.00%	100.00%
Kunike	f	45	6	2	37	99
	%	44.30%	7.00%	1.60%	47.20%	100.00%
Kunike Barina	f	11	2	0	15	28
	%	39.30%	7.10%	0.00%	53.60%	100.00%
Malal Mara	f	23	0	0	5	28
	%	88.70%	0.00%	0.00%	11.40%	100.00%
Sambaia	f	35	1	0	11	47
	%	76.90%	1.80%	0.00%	21.30%	100.00%
Tane	f	34	8	0	4	46
	%	73.90%	17.40%	0.00%	8.70%	100.00%
Yoni	f	116	3	0	10	129
	%	89.90%	2.30%	0.00%	7.80%	100.00%
Total	**f**	**444**	**29**	**2**	**124**	**599**
	%	**74.10%**	**4.80%**	**0.30%**	**20.70%**	**100.00%**

Table A3. Frequency and percentage distribution of IVSs by topography.

Chiefdom		Clay	Loam	Sandy	Total
Gbonkolenken	Frequency (f)	15	11	18	44
	% of total	34.10%	25.00%	40.90%	100.00%
Kafe Simira	f	1	37	3	41
	%	2.40%	90.20%	7.30%	100.00%
Kalansogoia	f	0	22	0	22
	%	0.00%	100.00%	0.00%	100.00%
Kholifa Rowala	f	14	63	22	99
	%	11.40%	62.80%	25.90%	100.00%
Kholifa Mabang	f	7	13	5	25
	%	28.00%	52.00%	20.00%	100.00%
Kunike	f	41	28	21	90
	%	41.20%	33.30%	25.60%	100.00%
Kunike Barina	f	6	14	8	28
	%	21.40%	50.00%	28.60%	100.00%
Malal Mara	f	1	27	0	28
	%	2.30%	97.80%	0.00%	100.00%
Sambaia	f	3	42	2	47
	%	6.20%	89.40%	4.50%	100.00%
Tane	f	20	16	10	46
	%	43.50%	34.80%	21.70%	100.00%
Yoni	f	15	91	23	129
	%	11.60%	70.50%	17.80%	100.00%
Total	**(f)**	**123**	**364**	**112**	**599**
	%	**20.50%**	**60.80%**	**18.70%**	**100.00%**

Table A4. Frequency and percentage distribution of IVS soils by texture.

Chiefdom		0–10 cm	11–20 cm	21–30 cm	> 30 cm	Total
Gbonkolenken	Frequency (f)	19	24	1	0	44
	% of total	43.20%	54.50%	2.30%	0.00%	100.00%
Kafe Simira	(f)	2	38	1	0	41
	%	4.90%	92.70%	2.40%	0.00%	100.00%
Kalansogoia	(f)	3	17	2	0	22
	%	13.60%	77.30%	9.10%	0.00%	100.00%
Kholifa Rowala	(f)	63	32	2	2	99
	%	59.50%	38.20%	1.20%	1.20%	100.00%
Kholifa Mabang	(f)	11	8	6	0	25
	%	44.00%	32.00%	24.00%	0.00%	100.00%
Kunike	(f)	19	63	8	0	90
	%	21.70%	71.00%	7.40%	0.00%	100.00%
Kunike Barina	(f)	9	19	0	0	28
	%	32.10%	67.90%	0.00%	0.00%	100.00%
Malal Mara	(f)	2	15	7	4	28
	%	16.70%	52.30%	22.00%	9.10%	100.00%
Sambaia	(f)	2	39	6	0	47
	%	3.60%	84.90%	11.60%	0.00%	100.00%
Tane	(f)	27	19	0	0	46
	%	58.70%	41.30%	0.00%	0.00%	100.00%
Yoni	(f)	20	52	42	15	129
	%	15.50%	40.30%	32.60%	11.60%	100.00%
Total	**(f)**	**177**	**326**	**75**	**21**	**599**
	%	**29.50%**	**54.40%**	**12.50%**	**3.50%**	**100.00%**

Table A5. Frequency and percentage distribution of IVSs by soil depth.

Chiefdom		Spring	Stream	Total
Gbonkolenken	Frequency (f)	10	34	44
	% of total	22.70%	77.30%	100.00%
Kafe Simira	(f)	6	35	41
	%	14.60%	85.40%	100.00%
Kalansogoia	(f)	16	6	22
	%	72.70%	27.30%	100.00%
Kholifa Rowala	(f)	24	75	99
	%	27.10%	73.00%	100.00%
Kholifa Mabang	(f)	2	23	25
	%	8.00%	92.00%	100.00%
Kunike	(f)	25	65	90
	%	28.70%	71.30%	100.00%
Kunike Barina	(f)	18	10	28
	%	64.30%	35.70%	100.00%
Malal Mara	(f)	8	20	28
	%	24.30%	75.80%	100.00%
Sambaia	(f)	3	44	47
	%	5.40%	94.70%	100.00%
Tane	(f)	22	24	46
	%	47.80%	52.20%	100.00%
Yoni	(f)	37	92	129
	%	28.70%	71.30%	100.00%
Total	**(f)**	**171**	**428**	**599**
	%	**28.50%**	**71.50%**	**100.00%**

Table A6. Frequency and percentage distribution of types of water sources in IVSs.

Chiefdom		Perennial	Seasonal	Total
Gbonkolenken	Frequency (f)	8	36	44
	% of total	18.20%	81.80%	100.00%
Kafe Simira	(f)	17	24	41
	%	41.50%	58.50%	100.00%
Kalansogoia	(f)	8	14	22
	%	36.40%	63.60%	100.00%
Kholifa Rowala	(f)	25	74	99
	%	17.80%	82.20%	100.00%
Kholifa Mabang	(f)	3	22	25
	%	12.00%	88.00%	100.00%
Kunike	(f)	23	67	90
	%	29.40%	70.60%	100.00%
Kunike Barina	(f)	11	17	28
	%	39.30%	60.70%	100.00%
Malal Mara	(f)	4	24	28
	%	33.40%	66.70%	100.00%
Sambaia	(f)	38	9	47
	%	81.40%	18.60%	100.00%
Tane	(f)	2	44	46
	%	4.30%	95.70%	100.00%
Yoni	(f)	28	101	129
	%	21.70%	78.30%	100.00%
Total	**(f)**	**167**	**432**	**599**
	%	**27.90%**	**72.10%**	**100.00%**

Table A7. Frequency and percentage distribution of IVS water regime types.

Chiefdom		4–6 months	7–8 months	9–10 months	No response	Total
Gbonkolenken	Frequency (f)	10	11	22	1	44
	% of total	22.70%	25.00%	50.00%	2.30%	100.00%
Kafe Simira	(f)	20	12	9	0	41
	%	48.80%	29.30%	22.00%	0.00%	100.00%
Kalansogoia	(f)	6	13	3	0	22
	%	27.30%	59.10%	13.60%	0.00%	100.00%
Kholifa Rowala	(f)	52	27	20	0	99
	%	53.10%	25.50%	21.50%	0.00%	100.00%
Kholifa Mabang	(f)	16	5	4	0	25
	%	64.00%	20.00%	16.00%	0.00%	100.00%
Kunike	(f)	36	23	31	0	90
	%	36.10%	24.90%	39.10%	0.00%	100.00%
Kunike Barina	(f)	12	6	10	0	28
	%	42.90%	21.40%	35.70%	0.00%	100.00%
Malal Mara	(f)	7	14	7	0	28
	%	34.10%	37.90%	28.00%	0.00%	100.00%
Sambaia	(f)	35	6	6	0	47
	%	76.10%	12.40%	11.60%	0.00%	100.00%
Tane	(f)	19	18	9	0	46
	%	41.30%	39.10%	19.60%	0.00%	100.00%
Yoni	(f)	37	52	40	0	129
	%	28.70%	40.30%	31.00%	0.00%	100.00%
Total	**(f)**	**250**	**187**	**161**	**1**	**599**
	%	**41.70%**	**31.20%**	**26.90%**	**0.20%**	**100.00%**

Table A8. Frequency and percentage distribution of the duration of water in IVSs.

Chiefdom		Developed and abandoned	Fully developed	Partially developed	Partly developed	Undeveloped (virgin)	Total
Gbonkolenken	Frequency (f)	1	5	22	9	7	44
	% of total	2.30%	11.40%	50.00%	20.50%	15.90%	100.00%
Kafe Simira	(f)	0	1	0	1	39	41
	%	0.00%	2.40%	0.00%	2.40%	95.10%	100.00%
Kalansogoia	(f)	1	0	0	0	21	22
	%	4.50%	0.00%	0.00%	0.00%	95.50%	100.00%
Kholifa Rowala	(f)	1	0	16	37	45	99
	%	0.60%	0.00%	19.10%	54.20%	26.20%	100.00%
Kholifa Mabang	(f)	0	1	6	8	10	25
	%	0.00%	4.00%	24.00%	32.00%	40.00%	100.00%
Kunike	(f)	1	20	36	15	18	90
	%	1.90%	17.90%	38.40%	14.00%	27.80%	100.00%
Kunike Barina	(f)	1	4	8	10	5	28
	%	3.60%	14.30%	28.60%	35.70%	17.90%	100.00%
Malal Mara	(f)	0	0	6	4	18	28
	%	0.00%	0.00%	13.70%	27.30%	59.10%	100.00%
Sambaia	(f)	0	16	8	3	20	47
	%	0.0%	38.8%	14.3%	5.4%	41.6%	100.0%
Tane	(f)	0	4	15	17	10	46
	%	0.00%	8.70%	32.60%	37.00%	21.70%	100.00%
Yoni	(f)	1	5	13	5	105	129
	%	0.80%	3.90%	10.10%	3.90%	81.40%	100.00%
Total	**(f)**	**6**	**56**	**130**	**109**	**298**	**599**
	%	**1.00%**	**9.30%**	**21.70%**	**18.20%**	**49.70%**	**100.00%**

Table A9. Frequency and percentage distribution of IVSs by development status.

Appendix B. Total area of different ecologies by chiefdom in Tonkolili District

No.	Chiefdom	Upland	Boliland	IVS	Riverine	Mangrove
1.	Gbonkolenken	688.38		71.12	14.50	
2.	Kafe Simira	545.86		59.555	0.585	
3.	Kalansogoia	392.40		26.60		
4.	Kholifa (Rowala)	262.79	56.96	30.435	1.815	
5.	Kholifa Mabang	205.53	85.57	9.38	1.52	
6.	Kunike	703.7		86.3		
7.	Kunike Barina	248.75		23.25		
8.	Malal Mara	173.22	84.03	9.81	14.49	
9.	Sambaia	612.13		57.87		
10.	Tane	480.62		45.485	0.895	
11.	Yoni	1,031.69	62.73	136.66	7.92	
Total		**5,345.07**	**289.29**	**546.465**	**42.175**	**0**

Source: Agricultural Engineering Division, Ministry of Agriculture, Forestry and Food Security

Table B1. Total area (km^2) of different ecologies in Tonkolili District, by chiefdom.

Appendix C. Summary of the categorization of the inventoried IVSs

District	Number (% of total) and total area (ha) of swamps by category		
	Perennial (11–12 months running water, P1)	Seasonal	
		9–10 months running water (P2)	6–8 months running water (P3)
Kambia	80 (88.9%) 2,064 ha	9 (10%) 200 ha	1(1.1%) 30 ha
Koinadugu	243(100%) 2,077 ha	0	0
Port Loko	51 (44.3%) 13,215 ha	43 (37.4%) 2,170 ha	21 (18.3%) 1,294 ha
Tonkolili	118 (88.7%) 1,724 ha	13 (9.8%) 153 ha	2 (1.5%) 32 ha
Bo	86 (93.5%) 807 ha	6 (6.5%) 38 ha	0
Bonthe	53 (98.1%) 1,828 ha	1(1.9%) 12 ha	0
Moyamba	8 (4.8%) 64 ha	159 (95.2%) 1,350 ha	0
Pujehun	28 (82.4%) 823 ha	5 (14.7%) 72 ha	1(2.9%) 15 ha
Kenema	7(15.2%) 227 ha	32(69.6%) 525 ha	7(15.2%) 123 ha
Kono	34(100%) 568 ha	0	0
Western Area	19 (48.7%) 191 ha	12 (30.8%) 375 ha	8 (20.5%) 242 ha
Total: number (% of total) and total area (ha)	**727 (69.4%) 23,588 ha**	**280 (26.7%) 4,895 ha**	**40 (3.8%) 1,736 ha**

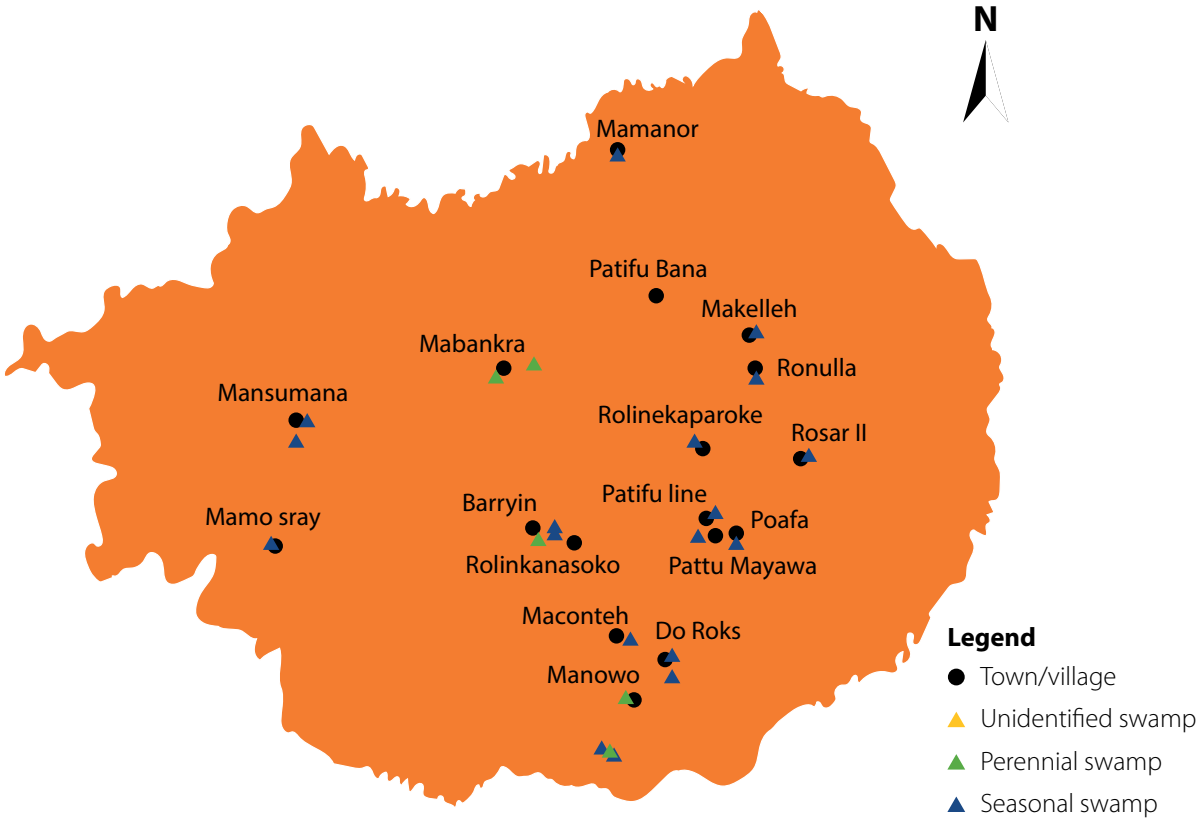
Source: Rashid-Noah et al. 2009

Note: The upper figures in each cell of the table are the total number of swamps and the percentage (in parentheses) of the total number of swamps recorded in the district, respectively. The lower bold figure in each cell is the total surface area (ha) of the swamps recorded.

Table C1. Summary of categorization of inventoried IVSs in Sierra Leone.

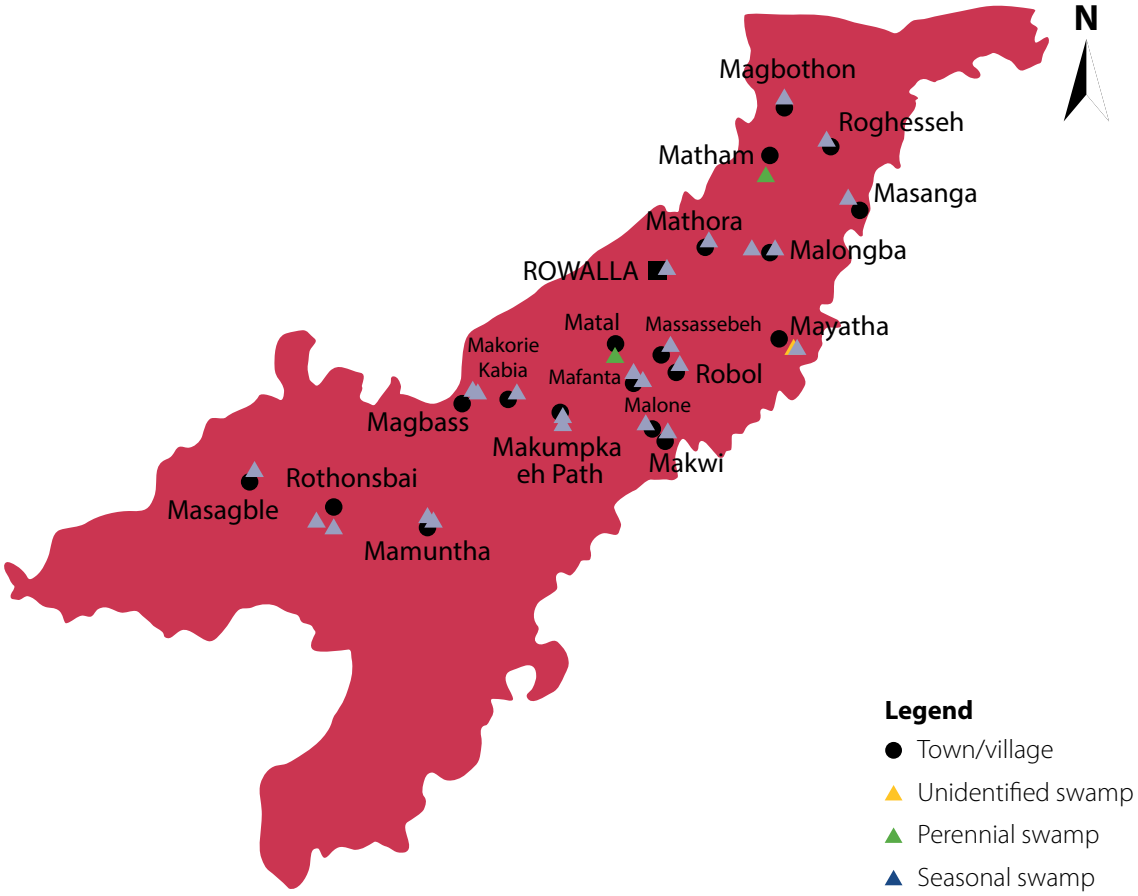
Appendix D. Maps of chiefdoms, towns and IVSs accessed

Map of Sierra Leone showing location of Tonkolili District with chiefdoms.



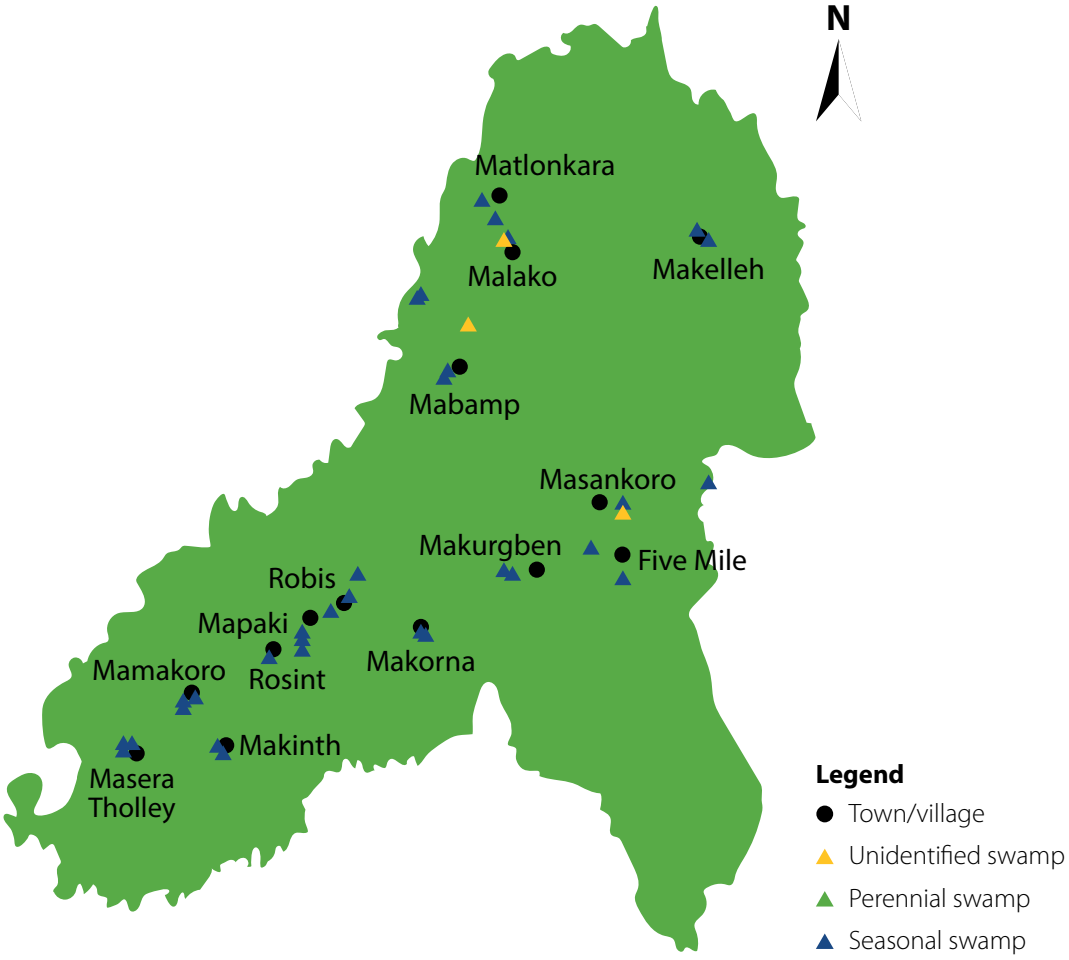
Location of surveyed IVSs in Gbonkolenken Chiefdom.

Location of surveyed IVSs in Kholofa Mabang Chiefdom.

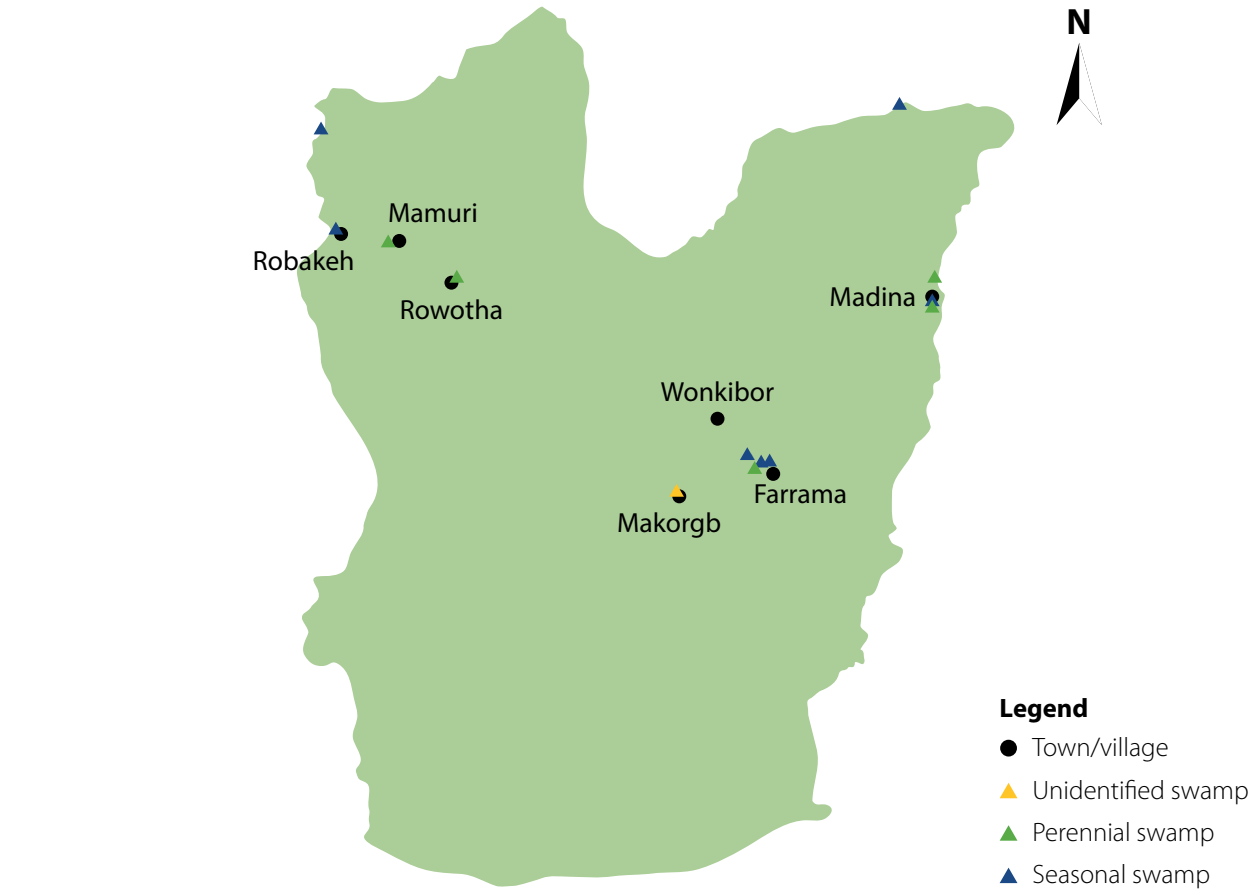


Location of surveyed IVSs in Kholifa Rowala Chiefdom.

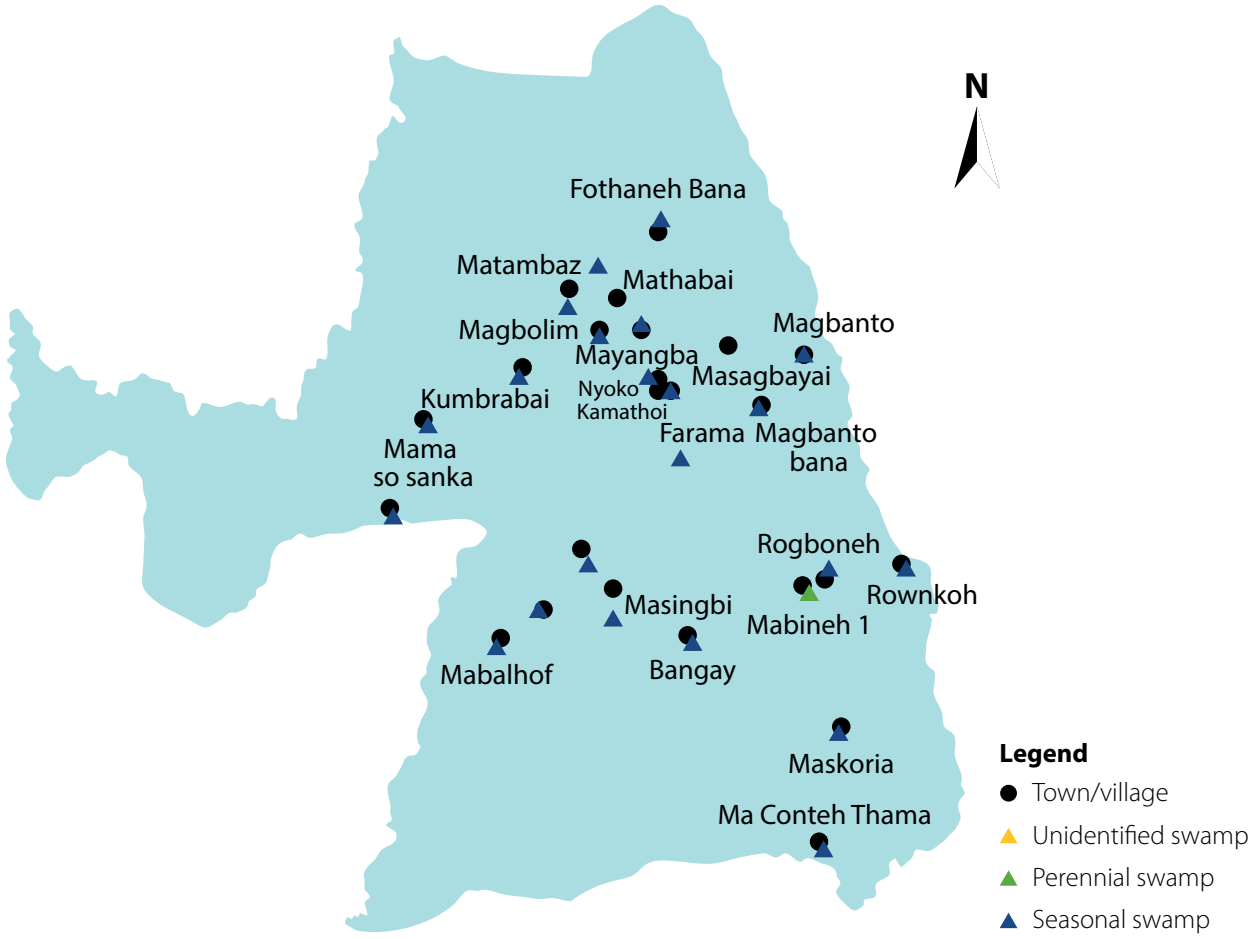
Location of surveyed IVSs in Kalansogoia Chiefdom.



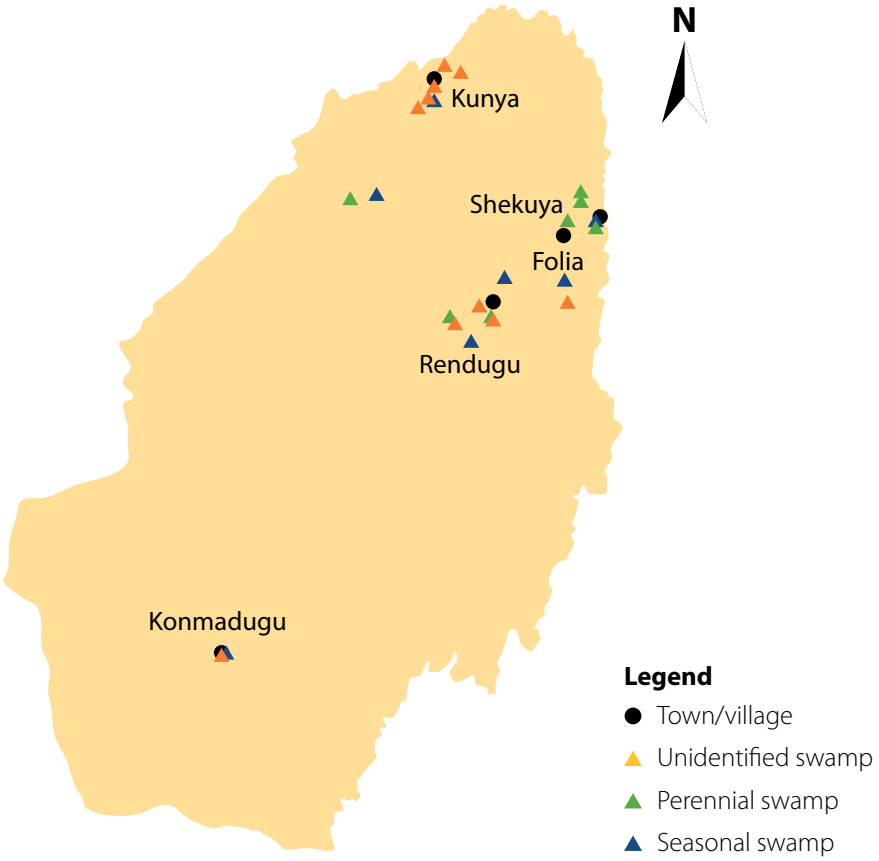
Location of surveyed IVSs in Tane Chiefdom.



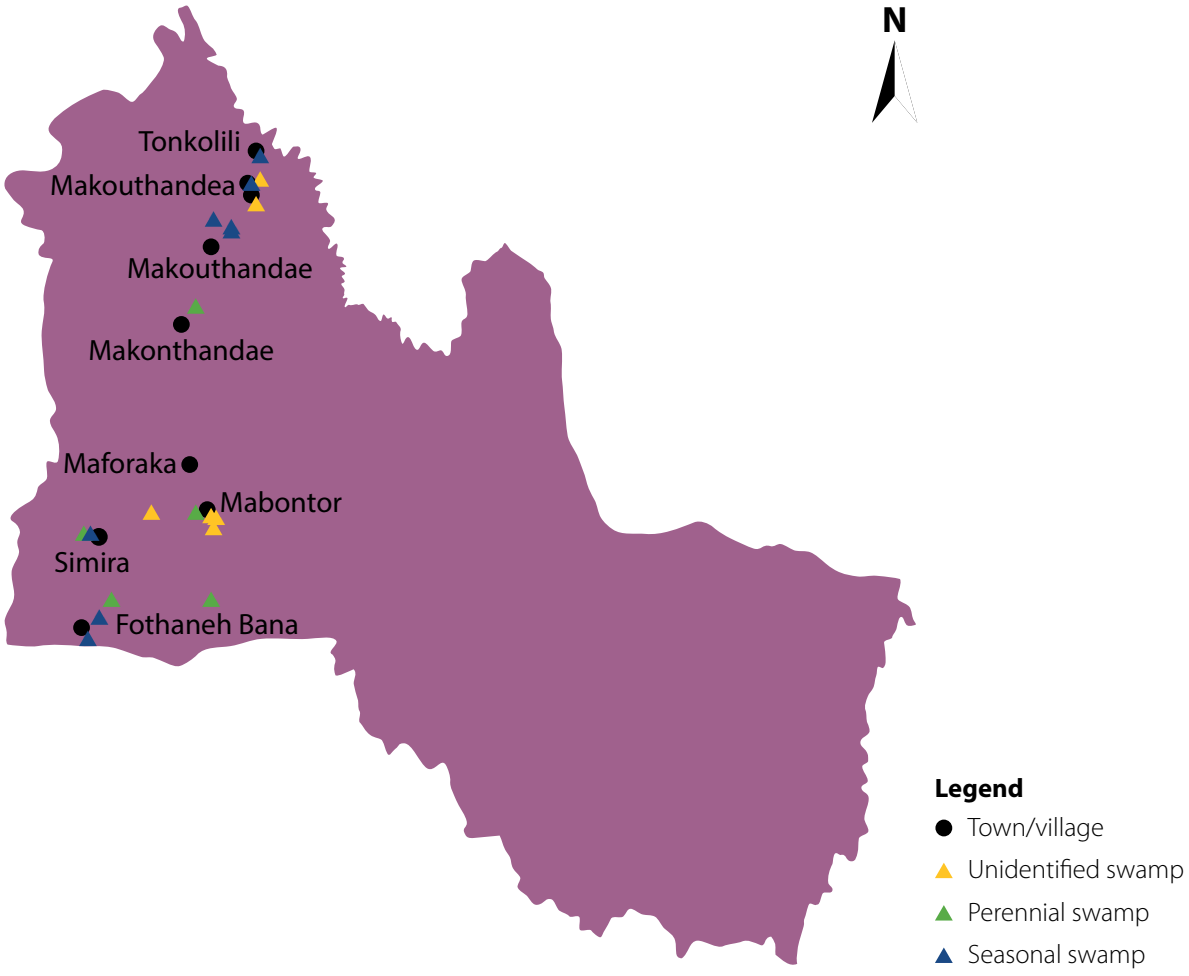
Location of surveyed IVSs in Kunike Barina Chiefdom.



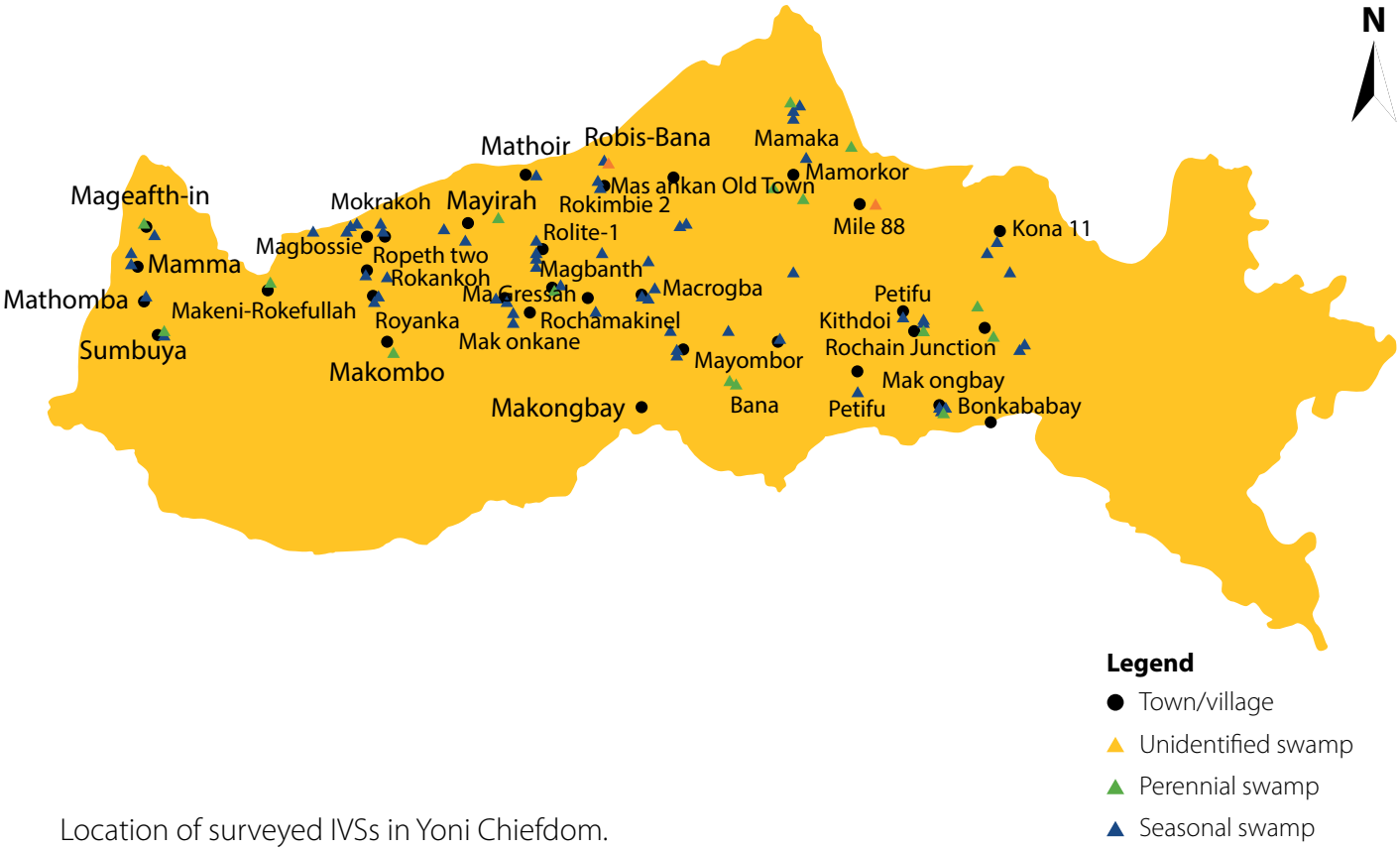
Location of surveyed IVSs in Kunike Chiefdom.



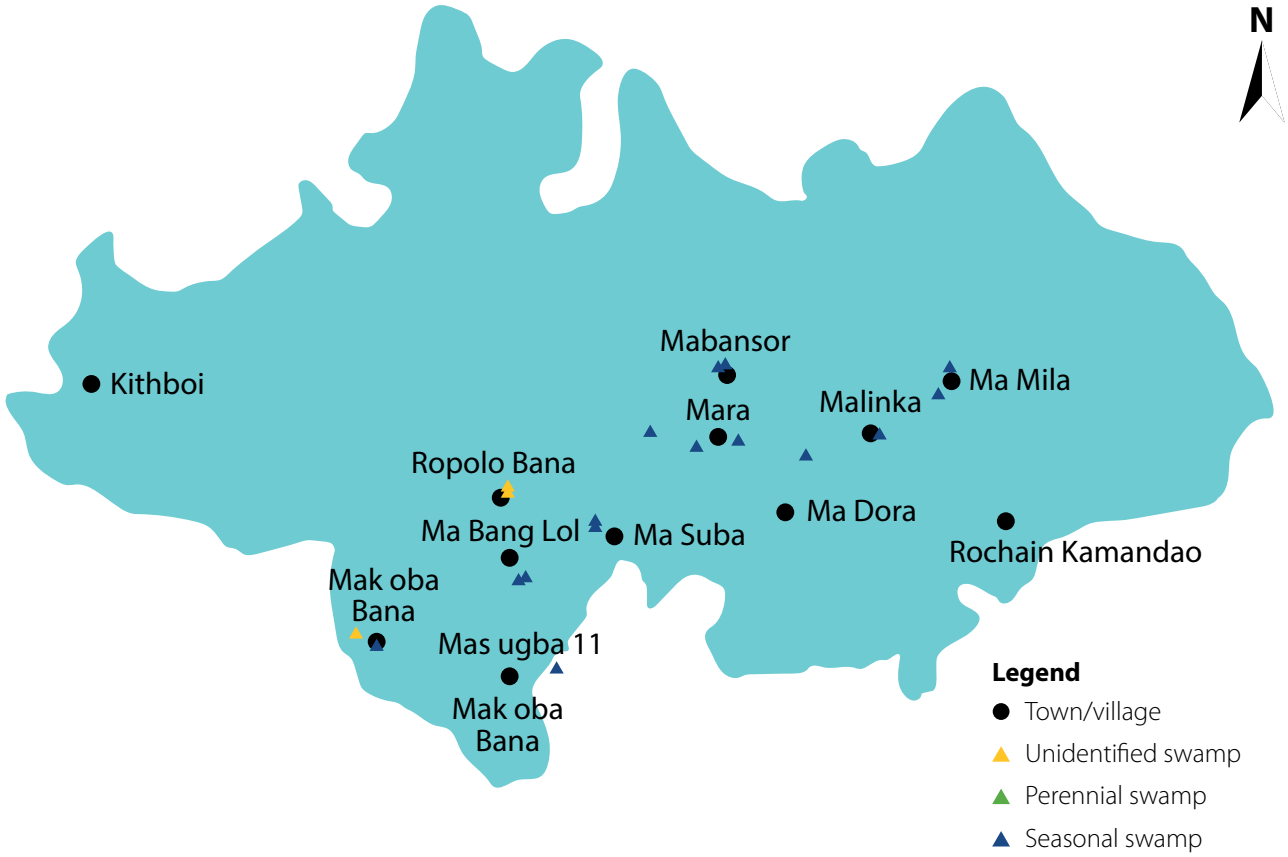
Location of surveyed IVSs in Sambaya Chiefdom.



Location of surveyed IVSs in Kafe Simira Chiefdom.



Location of surveyed IVSs in Yoni Chiefdom.



Location of surveyed IVSs in Malal Mara Chiefdom.

Photo credit: Back cover, Sunil N. Siriwardena/WorldFish

This publication should be cited as: Rashid-Noah AB, Johnny M, Olapade J, Phillips MJ and Siriwardena SN. 2018. Inland valley swamp assessment in Tonkolili District, Sierra Leone. Penang, Malaysia: WorldFish. Program Report: 2018-01.

© 2018. WorldFish. All rights reserved. This publication may be reproduced without the permission of, but with acknowledgment to, WorldFish.

www.worldfishcenter.org

100% RECYCLED

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

USAID
FROM THE AMERICAN PEOPLE

CGIAR RESEARCH PROGRAM ON Fish

WorldFish