cirad

Food and Agriculture Organization of the United Nations

CIFOR

WCS

SWM Technical Report Series: April 2022

SWM SUSTAINABLE WILDLIFE MANAGEMENT PROGRAMME

Towards sustainable wildlife management

An in-depth study for the promotion of community conservancies in Zambia and Zimbabwe

Supported by

Funded by the European Union

National partner

VI. THE FISHING SYSTEM

Hugues de Verdal, Chamunorwa Svosvai, Elodie Arnaud and Thierry Goli

Introduction

The objective of this chapter is, on the one hand, to summarize the observations made in the field of fisheries during the first years of the SWM Programme in KaZa and, on the other hand, to make proposals regarding the potential ways of developing aquaculture production and having sustainable and improved fishing practices in the CCs of the KaZa site. This chapter is part of the Result 3 "Alternative Proteins" of the SWM Programme and tries to develop innovative ways to improve fish resource access, in agreement with the theory of change of the SWM Programme in KaZa (see Chapter II). To achieve this objective, the chapter is organized into four main parts:

- water availability in the CCs of the KaZa site and hydrographic studies highlighting the possibilities of access to the water resource;
- access to fish in areas where water is present on a perennial basis (fishing and aquaculture) and in areas where the water resource is lacking (aquaculture);
- fish processing (practices diagnosis and processing improvements); and
- lessons learned and recommendations.

Materials and methods

The context of the area in terms of fish catching and/or production and preservation was assessed through the following activities:

- A comprehensive analysis of previous projects, studies and publications allowed the authors to consider different approaches to the sustainability of fish production, capture and processing.
- Meetings with national and local authorities directed the authors to a number of fish farmers, fishermen and fish processors. Interviews with these actors allowed a better understanding of the communities' expectations in technical and economic terms, to assess the sustainability of their production activity in the long term.
- Field missions were carried out to study hydrological trends based on time series analysis of remotely sensed images, examination of secondary data sources, and water quality analyses.

A. Water accessibility

A.1. Access to the water in the CCs

In relation to the production or capture of fish, the three CCs of the SWM Programme in KaZa could be defined according to their availability of and access to water. Water is a scarce resource in this region, except near the Zambezi River. It is possible to distinguish the CCs according to the aspects mentioned below:

- Simalaha CC (Zambia): in this CC, close to the Zambezi River, with constant access to water, fishing and aquaculture activities are developed. The main issues raised are the sustainability of fishing and aquaculture practices for which sustainability issues and their causes differ.
- Inyasemu CC (Zambia) and Mucheni CC (Zimbabwe): in both CCs, water is a scarce resource. During the rainy season, water is lost because it is not particularly easy to capture, and, during the dry season, water is scarce for humans, livestock and wildlife. This often leads to convergence of humans and animals for the same scarce water bodies, thus increasing conflicts between humans and wildlife. It is necessary to have the means to capture water before it is lost in order to increase the availability of water during the dry season. In these CCs, the main problem is how to capture, conserve and manage water.

In both Zambia and Zimbabwe, fish imports are relatively low and cannot be considered sufficient for human consumption. During the early years of the SWM Programme in KaZa, work on the fish farming system focused on understanding these different contexts and proposing innovative approaches to increase fish production and conservation.

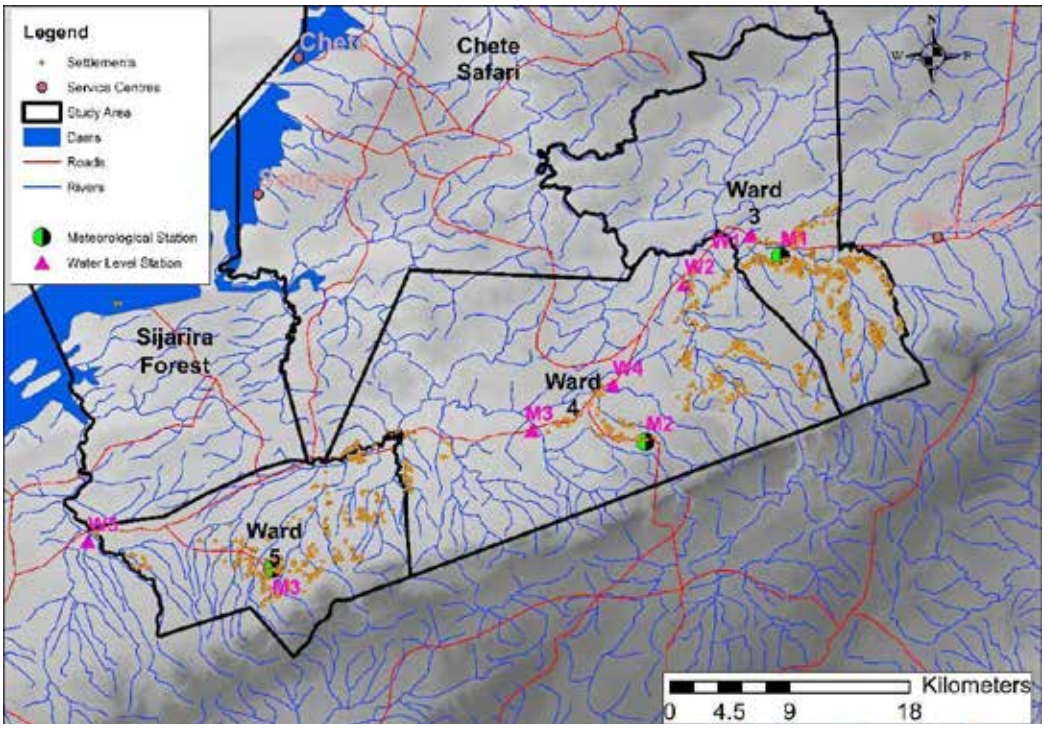

Figure VI.1: Hydrographic network in the Mucheni CC (*Source:* Dzvairo, 2019).

A.2. Hydrological studies

In order to develop fish farming and propose potential areas for the development of hydrological infrastructure, it is essential to know how the hydrological system is developed. In this context, hydrological studies have been carried out in two CCs: Mucheni in Zimbabwe and Inyasemu in Zambia, where water availability is particularly low. The following were the main objectives of the hydrological studies:

- to characterize the hydrological status of specific areas, current water uses and associated threats to the sustainability of water and water-dependent livelihoods and systems;
- to identify potential areas for the development of hydrological infrastructure and the conservation of natural hydrological features for sustainability of the livelihood activities of local communities; and
- to propose a protocol to local communities for reliable monitoring of the hydrological network for the establishment of a hydrological information management system (HIMS).

Hydrological studies provide the opportunity to target areas where boreholes and dams could be constructed to increase people's access to water without affecting other water systems (Figure VI.1).

In addition to the immediate needs, the following main recommendations will contribute to mitigate water-related constraints:

- drilling community wells for domestic water use and developing skills by providing training to some of the community members for well operation and maintenance;
- harnessing spring water in large reservoirs with a steady flow;
- developing fish farming as an alternative source of livelihoods in the area;
- invoking a sense of water stewardship within communities through the formation of river management committees and water user associations;
- raising awareness about the causes of water resource (river) degradation and adopting best practices in deep water conservation;
- enlightening the community on the principles of integrated water resource management as a basis for best practices in water resource management; and
- introducing communities to rainwater harvesting technologies that can help to mitigate water stress (dam construction, etc.).

B. Fish access

B.1. Permanent water availability areas (Simalaha CC)

B.1.1. Fish capture

The districts of Mwandi and Kazungula, which constitute the Upper Zambezi under the Inyasemu and Simalaha CCs, have 18 and 10 fishing camps, respectively, with about 1 125 fishers, 600 plank boats (locally known as *mikolo*) and 50 fiberglass boats. Mainly permanent, these camps are often flooded during the rainy season and must be abandoned, until water levels have fallen. This coincides with the fishing ban (1 December–28 February).

All the 28 fishing villages have at least one locally recognized landing site. Fish marketing is such that by the time the fishers set their nets, they have already received from traders either cash or payment in kind (food, clothing, fishing nets and even, in rare cases, boats); only a few fishers sell their catch in cash. The fish market normally has a large number of buyers. It is not entirely certain if fishers make a profit. Most buyers have formed a committee called the Fish Mongers Association and are based in Livingstone, where they are generally fish traders. In addition, five permanent lagoons in the Upper Zambezi region are designated as breeding areas managed by the customary authorities. They will soon be closed to fishing as they will be dedicated solely to fish breeding.

The fishery resource is managed by the community leaders and the Village Fisheries Management Committees (VFMCs) which monitor aquaculture development in the Fisheries Management Area under their jurisdiction and refer to the Zambian Department of Fisheries (DoF). Fishers must follow very strict net regulations. This is part of the DoF's objectives, to develop these breeding and safety zones to revive the declining fish resource. A significant reduction in the fish population was indeed observed in the Zambezi River at the time of the survey, either because there was an overall reduction in the fish resource due to low rainfall, or because the number of fishers has increased (meaning a reduction in catch per fisher without an overall reduction), or both. Some fishers pointed out that the fish reproduction was also not adequate, which could be partly explained by the low flood of 2019, which led to a reduction in the breeding grounds for fish. Overall, the main reasons behind this reduction in fishery resources could be an increase in the number of fishers and/or a reduction in fish spawning areas and in the floodplain, but also an increase in catches by unauthorized methods (Figure VI.2).

The number of fishers, which has increased over the last decades (20 percent of fishers arrived in the last five years in a village visited), is evidence that the income from fishing in the region is certainly higher than income from other sectors such as agriculture. The transboundary context

Figure VI.2: Forbidden mosquito net in the Zambezi River (©CIRAD/H. de Verdal)

of the Zambezi River (shared among Botswana, Mozambique, Namibia, Zambia and Zimbabwe) is complex and is not in favour of innovations to increase fish production in the river, as Zambian fishers consider that fishers from other countries should not catch "Zambian" fish. Furthermore, they do not agree to develop sanctuaries where fish could reproduce, as they fear that the larvae and fry could shift to other parts of the river. Nevertheless, they do not hesitate to fish on the Namibian side of the river, where the number of fishers is smaller and the quantity of fish higher.

If the official national ban makes the fishers aware of the link between capture and fish reproduction, it is not always adapted to local contexts and the fishers often continue fishing for their daily subsistence and/or trading at low values. Fishing sustainably during this period, i.e. respecting the overall dynamics of fish resources, could be considered for this purpose; however, the sale of fish is officially prohibited during the ban, which creates a good opportunity for farmed fish.

Improving fish breeding and designing new rules adapted to each specific context are key areas to sustain fish capture that the SWM Programme in KaZa is promoting. To prohibit fishing activities in specific areas known to fishers as being breeding areas in order to maintain fish breeding should be considered, as well as guarding against the danger of the larvae and fry being released into the surrounding waters and protecting them from illegal fishing activities or predators like crocodiles. It could also be envisaged to authorize, under certain conditions, the capture of fish species that are not subject to global conservation, and to target certain lagoons or areas of water closed off from the river, where fertilization with cow manure or feeding with maize or rice bran could improve natural productivity and increase the quantity of fish produced.

Such improvements involve an understanding of how able the local communities are to put effective rules in place to protect these areas and share the harvested fish through working in collaboration with customary authorities as well as official services.

B.1.2. Aquaculture

Field visits, discussions and economic analyses operated by the SWM KaZa team show that fish farming activities were not economically viable because production costs were higher than profits. Many funded aquatic ponds have closed; the empty ponds were only operational for the duration of funding. Active fish farmers use gas-driven pumps, usually paid for with former projects' funds, but gas is expensive and pumps can break, with no skill to repair them; solar pumps, though more expensive, could be an alternative. In addition, the sandy soil in this flood zone imposes a dam lining to develop the fish ponds, which is also an expensive solution as plastics generally do not last more than one year. The consequent leakages increase the use of pumps, and therefore the costs, with no positive outcome. Overall, the fish farms are embedded in an integrated system where the fish farmers buy fry and feed from the DoF, which clearly tends towards the fish farming system without a real willingness to adapt its vision to the context. As a consequence, this system with pump, fry and pellet feed makes fish very expensive to produce and sell, and aquaculture is not sustainable in the long term. To develop alternative feeding systems with organic fertilization or a mixture of manure and pellets could benefit the fish farmers, but there is a lack of a network to discuss these innovative techniques.

The priorities of the SWM Programme in KaZa are based on the following simple principles:

- Integrated production systems to reduce the average cost of production and to maximize profitability. Another type of production system could optimize resource consumption,

like integrating livestock or crops into the farming system to reduce feed costs. Such a combination allows the pump to irrigate the garden while also filling the pond, and reduces the investment cost for irrigation equipment.

- Development of farmers' organizations and skills through capacity building and establishment of sustainable networks to provide inputs (fry, broodstock) or consultation.
- Improved accessibility of fry, whose high price is linked to a low survival rate (between 20 and 50 percent), while fry production is profitable in the western and southern provinces of Zambia.

In these conditions, fish farming along the river with a production cost higher than USD 2/kg is not sustainable. Extensive small fish farms appear not to be an appropriate option in this area, thus the SWM Programme in KaZa intends to develop systems based on seasonal ponds, such as in lagoons after floodplains, that also could be used for fishing during the ban.

B.2. Restricted water availability areas (Mucheni CC and Inyasemu CC)

In Inyasemu CC (Zambia) and Mucheni CC (Zimbabwe), scarce water resources are the main constraints to livestock and productive garden development. Some personal or community initiatives are being taken to construct dams and ponds which are used to hold water during the rainy season and to provide water to people and livestock as long as possible. Some springs in the Chizarira mountain close to Mucheni CC give a steady flow to the Mucheni River and its tributaries, but this water disappears underground a few kilometres from the foot of the mountain range. Fishing is consequently not an option, except in a few small rivers where fishing activities can take place at the end of the rainy season, from about February to April (such as the Sichifulo River in the Inyasemu Game Management Area in Zambia). To increase water availability, it has been proposed to construct large dams and boreholes to reach the water table, or to build small dykes across a drainage channel or in the bottom of a valley; harnessing spring water could be another option. Such innovations have been made possible with the intervention of the NGO CARE (in Inyasemu CC) and government programs (in Mucheni CC). During the dry season, many of these water points dry up and farmers have to migrate in search of water for their livestock. Growing crops or fishing is not the way to increase livelihoods, but rather it serves as a means to ensure the resilience of the agricultural system. In such areas, the main challenges are the management of extreme rainfall to prevent floods and the harvesting of rainwater to maintain water supplies, and then the lack of water for people, livestock and wildlife with an increase in human–wildlife conflicts.

The ways forward for the SWM Programme in KaZa are described in the next sections.

B.2.1. Seasonal ponds development

In these regions where water is scarce and not perennial, there are, to the authors' knowledge, no real fish farms established so far. Except in the rare places where the springs benefit from groundwater, it is not possible to dig ponds that will store the water all year round without the need for pumping. In this context, the main approach is to take the seasonality of water into account. This seasonal water is important at the end of the rainy season and the challenge in designing a new model of fish farming could be to allow fish farmers to enhance their fish production capacity. Farmers desire to develop water bodies that will easily conserve water seasonally and, if possible, throughout the year. Community and individual initiatives have been noted (Figure VI.3).

Figure VI.3: Dam built by the village community to catch and store seasonal water in Nyawa Chiefdom, Zambia (©CIRAD/H. de Verdal)

B.2.2. Extensive and community fish farming

Trying to set up fish production based on the natural productivity of the pond is a reliable option because the cost of feed is not significant. Moreover, the development of extensive fish farming activities would reduce the production costs to less than USD 2/kg, which would allow fish farmers to make a profit. It could be interesting to promote such an approach where construction of innovative systems valorizing the fish resource in agricultural water bodies is put in place. Some groups have shown interest in such farming systems: in Inyasemu CC, a group of women is willing to install a network of small tanks near the wells to conserve broodstock during the dry season. The possibility of producing fry in these reservoirs should be tested to improve the loading of the pond dams. All the motivated smallholders, both male and female, are willing to work with such a project in order to set up a system capable of producing fish that can be sold at USD 2/kg. As a quantitative objective, a net production (the difference in weight between harvested and stocked fish) of 500 kg/ha/year seems achievable. This co-construction process must be iterative and should last three to four years in order to find a set of techniques well adapted to the environment. For example, the appropriate techniques to keep the spawning fish alive in small ponds and to maintain them in good condition are not yet defined.

B.2.3. Need for technical advice

A field officer capable of leading the dam co-construction process is necessary. He or she should have several skills such as the ability to understand and motivate people, group leadership and field training. He/she should be supported by a team of experts providing methodological

and technical advice. It would be useful to employ some interns (mixing international students and Zambian/Zimbabwean students from colleges and universities) to better evaluate the ongoing process. At the institutional level, an environment needs to be established where open discussions including customary authorities on the one hand and official services on the other can be held. In addition, it seems important to carry out a technical evaluation of dams that have already been built (for example, in Zambia by the Technical Services Branch [TSB] which is a service shared between the Ministry of Livestock and Fisheries and the Ministry of Agriculture). This would allow the dams to be evaluated and ensure that they are in line with the beneficiaries' objectives. In the Mucheni CC, it was important to carry out a technical assessment of the flow of natural springs and to find ways to store the water before it disappears into the ground (Kalahari sands) some few kilometres from the Chizarira Mountains (Pender and Rosenberg, 1995). The harvested water can be used for integrated fish–animal–horticultural production.

The SWM Programme in KaZa will be involved in a pilot programme using a few seasonal ponds in areas with limited water availability in order to highlight the possibilities and constraints of these aquaculture systems. This programme is divided into six steps: (i) identification of the beneficiaries (small owner or community with seasonal ponds); (ii) design of plans on how to find fish and transport them to the beneficiaries' farms; (iii) storage of fish in the targeted seasonal ponds; (iv) training of beneficiaries on the main actions required for the aquaculture process; (v) discussion with the beneficiaries on the next steps and on their requests and attempts; and (vi) evaluation of the opportunities and constraints for the beneficiaries of this activity. The process of co-developing new fish farming systems with local beneficiaries will lead to the design of farming systems that are profitable and manageable without the support of external actors.

C. Fish processing and marketing

C.1. Key results

C.1.1. Current fish processing practices in Zambia

C.1.1.1. Fish processing stakeholders

Meetings with stakeholders involved in the fish processing sector were held in three villages/fishing camps along the Zambezi River (Musulekwa village, Yoelo fishing camp and Kabulang'osi village). The distinction between village and camp was based on the fact that, in camps, fish processors leave when they have enough processed fish to sell and do not necessarily return. Fish for processing is captured or brought to fishers from the same village/camp. Fish processors leave to sell processed fish in Livingstone but could go as far as Choma or Lusaka, the capital city.

In Niawa Chiefdom (Inyasemu CC), fish processing activities are limited to the rainy season when the Sichifulo River flows; therefore, they were not observed during the field visit. The authors were told that people from and outside Nyawa fish and process fish to sell it as far as Democratic Republic of the Congo some hundreds of kilometres away. Among the dried fish sellers met in markets of some villages, one in Nyawa was a fisher selling the fish he processed himself over 150 km from the market. This information is in accordance with a market survey conducted in Katima Mulilo (which is across the river from the Zambian sites of the SWM Programme in KaZa

Figure VI.4: Smoking ovens at Kabulang'ozi fishing camp in Yeta Chiefdom (©CIRAD/E. Arnaud)

along the Zambezi River) during a previous project (Simasiku *et al.*, 2018). This survey showed that dried fish vendors (all women) were travelling to fishing villages in the floodplain for a week or two to buy fresh fish and process it on site.

Fish processors are individuals and there is no processor organization or collaborative dynamics among different processors. The labour involved in firewood collection appears to be the main reason. In the areas visited, there is no fish processing company nor association of producers or processing plants even at a small scale for collaborative initiatives.

C.1.1.2. Amounts of fish processed

There are a huge number of processors (about as many as there are households), each processing small amounts of fish (often a few kg/day). It is thus impossible to estimate at this stage the quantity of fish processed in the Zambian sites of the SWM Programme in KaZa. However, it is reported that 65 percent of fish production is smoked or dried in Zambia (FAO, 2006). The proportion of processed fish is highest in the seasonal fishing camp of Nyawa (95 percent of fish are said to be processed) and it is assumed to be the same in the other remote areas of Yoelo and Kabulang'osi along the Zambezi River. This is due to the lack of a cold chain system and the absence of fish traders who come to buy fresh fish and transport it on ice boxes as observed in Musulekwa.

C.1.1.3. Processing methods

Processing is carried out on captured fish: barbel fish/catfish (*Clarias spp*.), breams tilapia (*Oreochromis spp.*) and silver fish (unknown species) in Nyawa Chiefdom. In processing, fish is mainly eviscerated and split dorsally. Catfish are processed whole but are destined for export to

Democratic Republic of the Congo. The processing techniques include mainly hot-smoking and sun-drying. Salting, which is usually used as a preceding step before drying/smoking, does not seem to be common in the Zambian sites of the SWM Programme in KaZa, though people declare that they are aware that salt can be used, which can be explained by some supply issues and consumer preferences. Sun-drying and hot-smoking might be used in combination, without making a distinction between dried and smoked fish. Smoking might be linked to the presence of cooking fires in the kitchen where fish is stored overnight. It also could be used during cloudy/rainy days when sun-drying is not possible. The duration reported for the sun-drying and hot-smoking is highly variable as it depends on the weather and the way they are combined. The durations could not be precisely verified but generally it was reported to be three to five days for sun-drying and a few hours to one day for hot-smoking. Processing is done with basic equipment such as direct smoking ovens (Figure VI.4), sun-drying on rocks or drying racks in the open air (Figure VI.5).

C.1.1.4. Yields/shelf life/prices

The moisture content of processed fish bought in Nyawa village markets was estimated to be 10–15 percent. A high level of dryness during processing thus seems expected. The processing yield could therefore be estimated at about one-third of fresh fish.

Both hot-smoking and sun-drying extend the shelf life of fish by decreasing the moisture content, with hot-smoking allowing faster removal of water compared to sun-drying. Depending on the extent of water removal, fish can be stored for a few days to a few months for the most-dried products (fish with 10 to 20 percent moisture content).

Processed fish is sold at USD 6/kg, which is equivalent to USD 2/kg of fresh fish considering the weight loss during processing. Whereas the price of fresh fish, whether imported, caught from the river or produced at a farm through aquaculture, is twice that (around USD 4/kg), except along the river side where fresh fish can be sold at USD 1/kg. Hence, it is more profitable to sell the fresh fish in markets farther from the river at USD 4/kg. This explains why fish is only processed where people cannot sell it fresh.

Processed fish is an essential source of protein, especially on markets far from fresh fish production areas. Post-harvest processing plays a crucial role, especially when fish is not sold fresh or consumed soon after the capture. It avoids physical losses of fish because all the considered fishing areas in the CCs are far from the markets and cold storage facilities are generally lacking. Fish processing also allows fishers to keep the fish caught for their own consumption during the fishing ban.

Figure VI.5: Fish being sun-dried at Kabulang'ozi fishing camp in Yeta Chiefdom (©CIRAD/H. de Verdal)

C.1.1.5. Challenges and identified risks

Health hazards for consumers can result from inadequate practices and bad weather conditions during the processing steps. The following sanitary quality defects can be found in processed fish:

- bad microbiological quality;
- biogenic amines and toxins from pathogenic bacteria; and
- excessive content of carcinogenic polycyclic aromatic hydrocarbons (PAHs) due to the smoking equipment used, the long processing time required and the lack of knowledge about good practices regarding drying and hot-smoking.

Many constraints linked to fish processing have been identified, as follows:

- The processing only by smoking on direct fire ovens/kilns should be avoided (high PAH hazards).
- The use of charcoal is not an option due to its high cost, which most of the fish processors cannot afford.
- Wood consumption should be reduced. Wood collection and availability was often cited as the major challenge for fish processors along with the scarcity of fish.
- Processing is done on a very small scale, mostly by individuals or at the household level. There is no presence of fish processing companies, associations of producers or even a small processing unit/site for collaborative initiatives in the Simalaha CC. There are, rather, many processors, with each of them processing small amounts of fish (often a few kg/day). The absence of an organization of processors makes the actualization of economies of scale and the implementation of efficient technologies difficult.
- There is no fish processing technical centre for capacity building of fishers in the area.
- The stakeholders have no investment capacity.

C.1.2. Evaluation of improved fish processes available in other countries in the context of the KaZa sites

The potential of improved equipment/methods for hot-smoking and sun-drying fish in the context of the Zambian sites of the SWM Programme in KaZa was assessed. Their potential to overcome some of the challenges identified is summarized in Table VI.1.

Table VI.1: Pros and cons of several fish hot-smoking and sun-drying equipment or methods

Smoking ovens	Adapted to small quantity of fish	Allows concomitant drying and smoking	Requires charcoal	PAH reduction
Chorkor (Bomfeh *et al.*, 2019)	-	+	-	-
Systems with deported fire (Gret, 1993)	+	-	-	+
FTT-Thiaroye (Ndiaye *et al.*, 2015)	-	+	+	+
WorldFish oven (Kwofie *et al.*, 2019)	+	+	-	unknown
Radiant plate smoker (Ekomy *et al.*, 2013)	-	+/ -	-	+
Succession of charcoal and wood in traditional ovens	+	+	+	+
Sun-drying equipment	Adapted to small quantity of fish	Subject to bad weather and dust insects		
Kiraye CEAS (solar drying)	-	-		

C.2. Way forward

Fish processing does not lead to physical fish loss. However, fish loss should be assessed when fishing is at its highest level and for a short time in some fishing camps. Processing might also be necessary if there is a large production of fish through aquaculture. Moreover, the authorities should be warned that some processing practices may lead to production of harmful substances, such as microbial toxins and potential PAHs. Improved fish processing equipment would make it easier to collect wood, avoid the continuous monitoring of the products during processing, and reduce wood consumption.

Nevertheless, the introduction of any modern smoking and sun-drying equipment or the use of charcoal would not be sustainable due to the current socioeconomic context of the sites of the SWM Programme in KaZa. The low quantities processed per operator, their lack of investment capacity and the absence of a collective organization are the main barriers. Moreover, this improvement would increase the price of the fish due to the investment.

However, there are some recommendations that can easily be implemented by fish processors:

- Reduce hot-smoking time by the implementation of a longer sun-drying when the weather allows it. This would reduce wood consumption and contamination with PAHs.
- Increase the distance between the smoking fish and the fire to prevent the flames from touching the fish during the step of hot-smoking; and use a deported system for the generation of smoke during the phase dedicated to smoke deposition.
- Encourage the use of drying racks for sun-drying.

To be able to go further in the improvement of the processing techniques by the fish processing operators, the following actions would be undertaken in the near future:

- Local capacity building and strengthening: It is essential to develop local capacity in order to upgrade and facilitate the fish processing operators at the technical and entrepreneurial levels. The starting point is a brainstorming and training workshop in Montpellier in 2021 on fish and meat processing taking into account socioeconomic aspects. It is intended for agents of Ministries, technical advisors and academics, with whom future collaborative actions will be launched. This workshop could lead to the redesign of adapted processing practices and equipment.
- Identification and testing with fish processing operator practices to improve processes. By relying on the strengthened local skills network, discussion with the beneficiaries can be organized to define their needs and highlight constraints to be considered in the innovation process. This network will be in charge of:
    - proposing actions such as training of communities and producer organizations that could emerge; and
    - testing of adapted drying and smoking equipment.

D. Lessons learned and recommendations

There is a high degree of variability between the analysed CCs in terms of area, country, context, geography, demography, governance, etc., and therefore it is not easy to understand how decisions are made and what the consequences of their decisions and discussions would be for the direct beneficiaries of the SWM Programme in KaZa.

From this study, three main recommendations can be developed:

- It is important to carry out a fish value chain analysis (including potentially a post-harvest loss assessment). Such an analysis would allow a better understanding of the economic importance of the fishing system, more details on the fish market and trade gap, and actions to increase potential.
- In KaZa region where water is not perennial, the main recommendation is to valorize water with fish when water is available using seasonal ponds at the end of the rainy season. It is also important to think about the integration with the other activities of the household. Furthermore, developing networks of people wanting to try fish farming constitutes a good approach for the SWM Programme. It is also the best way to cope with resistance to change.
- Regarding fish processing, it is important to build local capacity for increased fish production from extensive fish farming. Supporting collaborative dynamics and organizational innovations in the fish processing sector will improve product quality and safety, reduce labour and decrease wood consumption.

Summary

This chapter is part of Result 3 "Supply of alternative protein is improved" of the Sustainable Wildlife Management (SWM) Programme. It reviews and characterizes the livestock production and grazing management systems in the three community conservancies (CCs) of Mucheni in Zimbabwe, and Inyasemu and Simalaha in Zambia, with a view to explore opportunities in the supply of alternative protein to resident communities in agreement with the theory of change of the SWM Programme in KaZa. Information and data were collected through literature reviews, qualitative and quantitative studies and surveys and general observation within the three CCs. The findings reveal that the farmers' major source of livelihood is livestock production with cattle, goats and poultry featuring as predominant species. The production systems are basic, "low input low output".