Capture-based aquaculture of *Clarias* catfish: case study of the Santchou fishers in western Cameroon

Victor Pouomogne
Institute of Agricultural Research for Development
Foumban, Cameroon
E-mail: pouomognev@yahoo.fr

Pouomogne, V. 2008. Capture-based aquaculture of *Clarias* catfish: case study of the Santchou fishers in western Cameroon. In A. Lovatelli and P.F. Holthus (eds). Capture-based aquaculture. Global overview. *FAO Fisheries Technical Paper*. No. 508. Rome, FAO. pp. 93–108.

SUMMARY

Aquaculture is an expanding activity in Cameroon. The limited availability of high quality fingerlings and feeds has been identified as one of the factors constraining its further development. Following the failure of government owned stations to meet this demand, effort is being put into seed production in private hatcheries. However, wild-caught seed remains important, especially *Clarias* species seed caught in the Nkam River basin in the western and littoral provinces of Cameroon.

This report presents a review of *Clarias jaensis* and *Clarias gariepinus* in Cameroonian capture-based aquaculture, with a focus on the market chain and socio-economic and environmental challenges related to the collection and use of juveniles of these species from the wild. The data and information presented here derive from research undertaken in participation with the fishers of the Nkam Valley in Western Cameroon under the Construction de l'Innovation Piscicole (CIP) project (Annex 1). Specific exchanges with key stakeholders involved in the fishery were conducted from January to March 2007.

Clarias spp. are silurid fish with interesting features for aquaculture. *Clarias gariepinus* appears as the most promising on account of its faster growth. However, it does not reproduce spontaneously in captivity, and hatchery operators need to induce spawning through injection of gonadotropic hormones. In addition, high mortality is observed in the early stages of the life cycle and relatively intense management is required to achieve high survival rates of fingerling in ponds, particularly with regards to reducing predation and cannibalism and ensuring the availability of adequate live feed needed during the larval phase. These constraints are currently being addressed through participatory research with Cameroonian fish farmers.

In the Nkam Valley, annual flooding provides millions of catfish juveniles that are collected by fishers and fish farmers for direct consumption or restocking of flooded ponds extensively used by farmers in traditional aquaculture. The collection of juveniles, along with the harvesting of flood ponds, takes place from November to March when the dry season results in the flooded rivers receding from farmed lowlands.

As aquaculture expands in the region, farmers from the highlands are now also seeking catfish juveniles, and a new economic activity has emerged to supply *Clarias gariepinus* fingerlings of homogenous sizes to buyers. This requires new inputs from the fishers including: sorting of species and sizes, handling the fish with greater care, stocking and nursing them in controlled rearing structures and better marketing. Of the many aspects affecting the survival of wild caught catfish in ponds, the two following were identified as critical: how long the fish remain in the mud during pond draining, and the water exchange rate during stocking and transportation.

In 2006, about 10 tonnes of catfish were harvested from flood ponds. Over 300 000 *Clarias jaensis* were collected and distributed for aquaculture, along with almost 50 000 *Clarias gariepinus*. In addition to fish consumed in the household (31 percent) or given to relatives (34 percent), estimated cash revenue of US$20 000 were received by the 100 fishing households under investigation.

Compared to farmers in areas around the urban centre of Yaoundé, farmers of the Nkam Valley appear to be consuming 10 times more fish. Most fishers were married (75 percent), with an average of 7 persons in the household. The relatively high literacy rate (>70 percent beyond primary school) provides the potential for training in sustainable management of the resource.

To improve the value of the catfish fingerling harvest to both collectors and consumers, it is recommended that fishers are: 1) trained in proper fish handling, and 2) ensure purchase and use of appropriate farming and handling equipment through some form of revolving credit plan. The positive influence of traditional beliefs of the Mbô people on the sustainable management of the fishery, both wild juveniles and broodstock for aquaculture purposes, is also discussed in the report.

INTRODUCTION

Catfishes of the genus *Clarias* (Siluroidei, Claridae) are widespread in tropical Africa and Asia (Sudarto, 2007). *Clarias gariepinus* is by far the most cultivated. However, as they do not normally reproduce spontaneously in ponds, *Clarias* catfish culture is constrained by seed availability. Induced breeding has been developed, but production systems and hatchery management techniques that make catfish seed of good quality readily available to all farmers are yet to be established in most African countries (Pouomogne, Nana and Pouomegne, 1998; Brummett, 2007). In these conditions, seed from the wild remains an important opportunity, when available.

The use of catfish seed from the wild for typical pond aquaculture is not documented in Africa. However, a number of reports have described the traditional practice of enhancing the natural entry of wild fish into flood ponds, such as the "fingerponds" in Lake Victoria wetlands (Unesco-IEH, 2005), and "whedoes" used in Benin and Togo (King, 1993). These traditional aquaculture facilities can be owned by individuals or communities. Due to their location in wetlands, they are often not able to be drained and are typically harvested by intensive capture fishing as water recedes at the end of the dry season, and are sometimes referred to as "amplified fisheries" rather than aquaculture (Mikolasek, Massou and Allagdaba, 2000; Dorey *et al.*, 2002).

This paper focuses on African catfishes, specifically the use of wild-caught *Clarias jaensis* and *Clarias gariepinus* for aquaculture in the western Cameroon highlands. Although aquaculture production based on this practice remains marginal in Cameroon, this case highlights the interplay between the protection of the environment, poverty alleviation from well-managed inland fisheries and the gains to the overall society when rights of minor native groups are respected.

The study is based on secondary sources of information and data derived from published papers and unpublished reports. The author is part of an action research team working with farmers in the study area since 2003 through numerous projects

FIGURE 1
***Clarias* spp. Right – *Clarias gariepinus* and *Clarias jaensis*; Left – *Clarias* catfish harvested from flood ponds**

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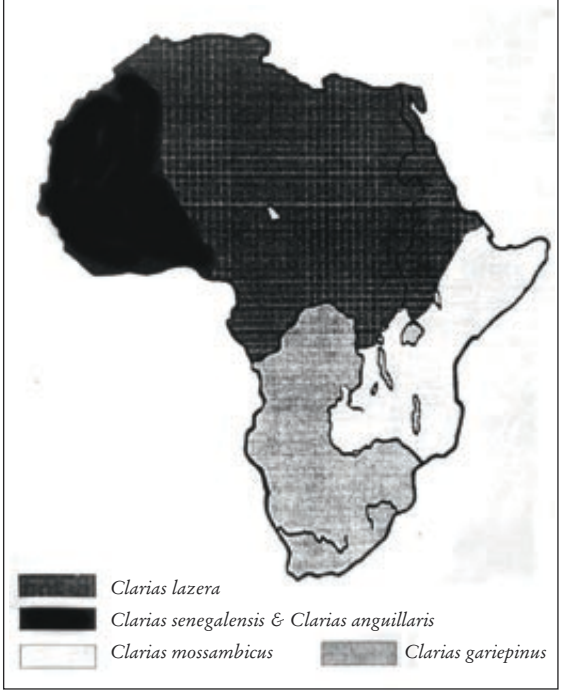
sponsored by the Ministry of Research and Innovation in Cameroon (MINRESI) and the French international cooperation agency. For the specific needs of the present study, additional primary source data and information were also collected from the field through interaction with fishers (see details on CIP project in Annex 1).

DESCRIPTION OF *CLARIAS* SPP. AND ITS USE IN AQUACULTURE

Taxonomy and life cycle

There are 58 species in the genus *Clarias* (Siluroidei, Clariidae) recognized in FishBase (2007), all living in freshwater, but able to tolerate salinities up to 2.2 ppt (Clay, 1977). Two species are the focus in the present study, namely *Clarias gariepinus*, and *Clarias jaensis* (Figure 1). Both are catfishes from the Clariidae family, which distinguish themselves from the other genera of the family by the presence of a single, long dorsal fin that extend nearly to the caudal fin base, among other distinguishing features. The naked mucus-covered body is elongate, eel-like, the head is flattened, and eyes are small. *Clarias gariepinus* grows bigger (maximum size recorded 1.7 m total length, in comparison to 0.5 m for *Clarias jaensis*) (Pauguy, Lévêque and Teugels, 2003). The skin of *Clarias gariepinus* is thicker than that of *Clarias jaensis*. The cephalic bones of the latter are almost visible throughout the relatively shorter and smoother under-surface of the head.

FIGURE 2
Distribution of *Clarias* catfish in Africa (after De Graaf and Janssen, 1996)



Clarias jaensis is the easier to handle of the two and shows a quieter behaviour in the rearing environment. *Clarias gariepinus* is usually dark spotted greyish coloured; *Clarias jaensis* is more dark yellowish. After cooking, *Clarias jaensis*' bones soften so that the whole fish can be consumed. According to the fishers in the Nkam Valley, *Clarias gariepinus* is the desirable and preferred aquaculture candidate, while *Clarias jaensis* is fovoured in traditional dishes and for marriages and other customary celebrations.

Clarias gariepinus, generally considered to be the most important clariid species for aquaculture,

has almost pan-African distribution, ranging from the Nile to West Africa and from Algeria to South Africa. *Clarias jaensis*' distribution is less known. In Cameroon, this species is found in the Wouri and the Sanaga river basins, usually sympatric with the introduced *Clarias gariepinus*. The broad adaptive capabilities of *Clarias* species allowed their introduction to Europe, the Middle East and Asia (Figure 2).

These clariid species are found in lakes, streams, rivers, swamps and floodplains, many of which are subject to seasonal drying. The most common habitats of these species are floodplain swamps and pools where the catfish can survive during the dry seasons due to their accessory air breathing organs (De Graaf and Janssen, 1996).

Gonadal maturation in *Clarias gariepinus* is usually associated with the rainy season. In Cameroon, reproduction begins in late March-early April with the start of the rainy season. Heavy flooding in the Nkam Valley is observed by October–November, and fingerling collection takes place a month later when the water recedes back to the river bed. Flood ponds are harvested from January to March, with production varying from 200 to 800 kilogram/100 m² pond. The average individual fish weight is 167 grams.

Fishery exploitation of *Clarias* catfish

Total freshwater fish production of catfish from the genus *Clarias* is estimated at 75 000 tonnes and is second only to Tilapia among the freshwater fish species captured in Cameroon (Ngok, Njamen and Dongmo, 2005).

In the Sanaga and Wouri River basins, total capture fisheries production is estimated at 15 000 and 4 000 tonnes, respectively. From this, catfish can be reasonably estimated to contribute approximately one third of the catch, i.e. 6 000 tonnes. The total national production of *Clarias* catfish may be close to 20 000 tonnes.

The collection of wild *Clarias* fingerlings for aquaculture is less important than fishing for direct human consumption. In Cameroon the collection of catfish juveniles for aquaculture is specific to the Nkam River basin while it remains a marginal activity in other rivers where *Clarias* spp. are fished.

Wild *Clarias* fingerlings

The weight of fingerlings collected for aquaculture ranges between 20–120 grams. Table 1 shows the length-weight relationships for the most commonly marketed fingerlings in the Nkam Valley.

Clarias are relatively robust fish and tolerant of low dissolved oxygen water levels. *Clarias jaensis* demonstrates a quieter behaviour, and is thus easier to handle compared to *Clarias gariepinus*. Nevertheless, the holding and feeding of fingerlings is problematic in Cameroon. The most common error is stocking with different sizes in the same container. As larger fish cannibalize smaller individuals, survival rates of less than 10 percent are common and can occur in less than 5 days of stocking. Another problem is artificial feeding. Uneaten feed rapidly deteriorates water quality, causing high mortalities among smaller fish and swollen bellies in larger specimens.

TABLE 1
Length–weight relationship for marketed fingerlings collected from the wild in the Nkam Valley

Clarias gariepinus					
Total length (mm)	175	180	195	200	227
Weight (g)	30	35	42	57,5	118,5
Clarias jaensis					
Total length (mm)	160	165	214	223	243
Weight (g)	30	36,5	80,9	95	132,5

Source: Pouomogne and Mikolasek, 2007.

Tilapia-*Clarias* polyculture

Nile tilapia is the most commonly farmed fish in Cameroon. In mixed-sex culture, this species produces large numbers of unwanted juveniles. Overcrowding is controlled by using predator fish. *Clarias gariepinus* is the most commonly utilized species for this. Large fingerlings of 15 grams are stocked with Nile tilapia at a 1:1 ratio and reared for 9 to 11 months. Unfortunately, catfish fry production from existing hatcheries in Cameroon is poorly organized and managed, and unit prices may vary from US$0.1 to 0.25. A recent economic analysis showed that at the current fish seed price of US$0.2 per 5 gram fingerling most rural farmers are losing money, as farm profitability is possible only with a fingerling unit price of US$0.1 or less (Brummett, 2005; Sulem *et al*., 2007). When wild seed are available, prices of *Clarias gariepinus* fingerlings are generally lower than US$0.1.

Clarias fingerling production and the benefits of wild-caught juveniles

African catfish reproduce in response to environmental stimuli such as a rise in water level and inundation of low-lying areas. These events do not occur in captivity and several techniques have been developed to induce artificial spawning on fish farms.

In Bamenda, located in the western highlands of Cameroon, ponds of about 300 m² are filled with ±20 cm of water and stocked with 4 mature couple of *Clarias gariepinus* (250–450 g weight) for 2–4 days in April (i.e. early rainy season). Water level is then increased up to 60 cm (artificial flooding) by early afternoon and spawning usually occurs at night. The number of fingerlings harvested 4–6 weeks later per kilogram female brooder is <400 and average weight is 5 grams. This is a rather poor outcome.

In one hatchery at Foreke, 10 kilometres from Santchou, hormone treatment is employed to ensure large-scale production of catfish fingerlings. Hormones used include Deoxycorticosterone Acetate (DOCA), Human Chorionic Gonadotropin (HCG), Luteinizing Hormon Releasing Hormone Analogue (LHRH-A) or pituitary glands from a catfish brooder, common carp, Nile tilapia and even frogs following specific technical procedures (De Graaf and Janssen, 1996; Pouomogne, Nana and Pouomogne, 1998). These procedures include hormone preparation, injection and stripping of the eggs from females following a precise time interval. Protecting the pond from predators is a key parameter in the survival of the fingerlings. In a well-managed pond, over 20 000 fingerlings can be produced, with an average weight of 5 g per kilogram/female brooder. Although the procedures are being simplified, only a few farmers have been exposed to them. However, with the support of the WorldFish Center and the Institut de Recherche Agricole pour le Développement (IRAD), a larger number of farmers are being trained in these techniques (Nguenga and Pouomogne, 2006; Sulem *et al.*, 2007).

For fish farming to develop sustainably in Cameroon, catfish fingerlings need to be available at less than US$0.1/unit compared to the current US$0.15–0.25 price. The seasonal availability of natural fingerlings in the Nkam Valley is certainly an economically viable source of fingerlings; however such resource needs to be sustainably managed.

For the flood ponds in the Nkam Valley, pond preparation is performed just after harvesting in January–March at the end of the dry season, with the extraction of the bottom mud and rehabilitation of the fish shelters (Hem and Avit, 1994). Sunshine stimulates natural productivity before the start of the next rainy season in early April (Table 2). In normal years, flooding of the Nkam River and its tributaries occurs in July–October. Flood ponds are inundated at that time and fish recruit naturally to find the necessary food and shelter. Depending upon the severity of drying between rainy seasons, pond productivity may rise for 1 to 3 years before the pond is actually harvested.

TABLE 2
Preparation of flood ponds at Santchou, Nkam Valley

Periods	Activities	Events
April–July	None	Rainy season starts; Weedy grasses and shrubs start invading the sites (the main shrub being *Alchornea cordifolia* or "ben" in the local language)
August–October	None	Ponds are inundated
November–December	Site visits	End of rainfall and dry season starts; collection of catfish fingerlings by fishers
January	Pond visit and planning of harvests; supplemental fish feeding by some farmers	Water retreat starts in ponds
February–March	Pond draining; fish harvesting; pond rehabilitation	Traditional rituals, site clearing, harvests; pond repairs; building of shelters inside the ponds
April	End of a cycle	Rainfall comes back, with weedy grasses

Source: Translated from Mfossa, 2007.

The collection of catfish fingerlings from fishing grounds (as opposed to flood ponds) begins in early December with the start of water retreat. The majority of the fish caught are sold for non flood pond stocking in the highlands or for consumption; some fishers may however add fingerlings to their flood ponds periodically. In this case, farmers provide supplemental feeding with table scraps. Average pond size and depth in Santchou valley are 40 m² (475 ponds, range 2–240 m²) and 1.7 m (range 0.5 to 3 m), respectively. Stocking occurs via natural recruitment during the annual pond flooding. Most ponds are harvested after a one-year rearing cycle (52 percent) or after 2 years (45 percent). Exceptionally high productions is sometimes recorded at up to 860 kg per 100 m² flood pond per year.

DESCRIPTION OF THE FISHING ACTIVITY

Geographic overview of juvenile collection in the Nkam Valley

With the flooding of the Nkam and Menoua valleys numerous refuge sites for the young catfish are established in the nearby lowland farms (Figure 3).

FIGURE 3
A collection area for *Clarias* catfish juveniles

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In addition to fishing for juvenile clariids, there is also a traditional practice of extensive fish farming of catfish in flooded ponds. The main villages concerned with the fishery for juveniles and the catfish aquaculture include Lelem, Ngang, Santchou and Fongwang. Ngang Island is particularly well known as a good fishing ground.

Fishing gear and materials used for the collection of *Clarias* juveniles

Fishing materials are generally artisanal and consist of 10 to 30 litre buckets, gasoline water pumps for draining water from the fishing grounds, hand nets, seine nets, cast

FIGURE 4
Fishing basket (right) and a two-wheel carrier used for transporting juvenile fish (left)

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nets and baskets used to catch the juveniles. Materials for transporting the catch from the fishing sites to the market includes 10–40 litre plastic or aluminium containers, canoes, bicycles, and wheelbarrows. (Figure 4).

Production statistics

Data on fishery production has not been regularly collected. Current estimates indicate values of 7.5 and 1.1 tonnes per year for *Clarias jaensis* and for *Clarias gariepinus*, respectively (Mfossa, 2007). Forty percent of the production consists of juvenile catfish averaging 10–40 grams in weight for potential use in aquaculture (approximately 0.3 million *Clarias jaensis* and 0.04 million *Clarias gariepinus*). National data indicate that the total freshwater aquaculture fish production in 2006 was 870 tonnes, of which 330 tonnes consisted of *Clarias gariepinus* (Pouomogne, 2007b).

Seasonality of fishing activities

Fishing begins in mid-November with the retreat of the water from the valley. The fishery usually continues until late March of the following year and stops with the arrival of the new rainy season. Professional fishers continue fishing throughout the year in other locations during the rainy season when heavy flooding precludes safe fish capture activities in the valley.

Fishing sociology – tribe, gender, division of labour

The Mbô, the indigenous people of the valley, are the main ethnic group involved in the fishery for juveniles and have ancestral rights to most fishing grounds. In Lelem village, the people of the Bamileke tribe own some farm areas in the lowlands where fishing for catfish juveniles can be undertaken.

Men, women and children all actively participate in the fishing, care of the flood ponds and harvesting activities. Men are particularly engaged in pond construction, management and harvesting, as such activities demand hard labour. Women are more involved in activities such as the distribution of the fish to the various destinations and smoking of the fish. Selling of the fish is mostly a male responsibility (Table 3).

Handling and holding

The distance from the fishing ground to the fisher's home, to the flood ponds and to the market varies from 0.5 to 15 kilometres. As mentioned above, juvenile *Clarias* are transported to the fish ponds by canoe, wheelbarrow or bicycle. When the destination is outside the valley, cars are used, e.g. for delivery to Kumba which is >300 kilometres

TABLE 3
Labour allocation in fish farming within flood ponds at Santchou, Cameroon

Activities	Men	Women	Children	Extended family members
Pond construction or renovation	*		*	*
Management	*		*	
Removing water during harvesting	*			
Harvesting	*	*	*	*
Removing mud after harvesting	*	*		*
Transportation	*	*	*	*
Selling	*		*	
Smoking		*	*	

Source: Che, 2007.

FIGURE 5
A typical concrete tank for holding catfish juveniles

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away. Prior to transport, the wild seed are kept in 100 litre containers, or in earthen or concrete tanks for up to a month (Figure 5). Water is renewed 1–2 times per day. Fish are fed on corn flour, with care to avoid over-feeding and deterioration of water quality.

In addition to the problems related to cannibalism and stocking fingerlings of similar sizes, key factors determining survival are the renewing of water twice daily and ensuring sufficient accessibility to air for the fish (i.e. use of a wider shallow container, rather than deep one). Another cause of high mortality after stocking appears to be related to the condition in which the fishing was performed. When fingerlings spend an abnormally long time in the mud during the draining and catching process, up to 100 percent mortality may occur.

AQUACULTURE DEPENDENCY ON WILD SEED

In the Nkam Valley there is no shortage of catfish fingerlings. *Clarias gariepinus* is in high demand and current production from wild capture is sufficient for the existing extensive flood pond aquaculture system. Outside of the valley, however, catfish fingerling demand exceeds supply. With an annual aquaculture production estimated at 330 tonnes nationwide, this demand is close to 1 million fingerlings, which is beyond what is currently availability from the wild (Pouomogne, 2007b).

Although *Clarias jaensis* is the more fished of the two species, farmers prefer *Clarias gariepinus* for its faster growth rate. According to Santchou fishers, *Clarias gariepinus* has been accidentally introduced from upstream hatcheries into the lowland flood ponds where it was not previously found. Most of these hatcheries are now closed due to mismanagement. High transportation costs protect the catfish resources of the Santchou area from major fishing pressure resulting from high demand from outside the valley. Current export outside the valley is mainly due to subsided aquaculture projects (Table 4). In addition, private fingerling producers are constantly improving their ability to provide quality fish seed at more competitive prices. Some of the PFP sporadically demand broodstock caught from the wild to expand the genetic variability of their base material. These efforts are supported by the research of international

(WorldFish Center, Centre de coopération internationale en recherche agronomique pour le développement – CIRAD) and national (IRAD) institutions (Nguenga and Pouomogne, 2006; Sulem *et al.*, 2007; Brummett, 2007).

Within the valley, the current extensive production system in flood ponds is moving towards intensification and studies are needed to determine the capability of the native species to sustain competition for food and habitat from introduced *Clarias gariepinus*. Currently, resource management of the catfish fingerlings remains sustainable with stocking of flood ponds being the major demand on the resource.

TABLE 4
Estimated numbers and destination of catfish juveniles fished in Nkam Valley (2006)

Buyers	Quantities[1]	Destination
Fishermen (bait)	2 000	Nkam Valley
Fish farmers (seed)	3 000	Fokoué (Dschang)
	200 000	Santchou (Dschang)
	10 000	Bamenda
	20 000	Kumba

[1] Both *Clarias gariepinus* and *Clarias jaensis*.

The introduced *Clarias gariepinus*, which is preferred over the native *Clarias jaensis*, is not heavily represented in the Nkam Valley recruitment. Unless *Clarias jaensis* becomes an interesting candidate for aquaculture, the limited availability of *Clarias gariepinus* seed in unlikely to support the growing aquaculture industry. Investigations on the potential of the local catfish species as a "police-fish" in tilapia pond culture are ongoing (Pouomogne and Mikolasek, 2007).

Access to the collection grounds for catfish fingerlings is governed by strict ethno-sociologic property rights. All revenues from the fishery belong to the fisher and the family owning the fishing area. Investments essentially consist of tools and labour for preparing the fishing area, for collecting the fingerlings and for stocking and marketing the fish. This market chain is currently highly profitable when compared to the profit generated by private hatcheries (Table 5). Margins will decrease with new native fishers demanding access to the fishing grounds. In addition, since the target species (*Clarias gariepinus*) is available in limited amounts in the valley, hatchery-produced seed may not suffer much from competition with wild seed. In the meantime private fingerling producers continue their efforts to improve the quality/price ratio and availability of hatchery-produced catfish fingerlings (Sulem *et al.*, 2006; Sulem *et al.*, 2007).

TABLE 5
Economics of catfish fingerling collection in Santchou, Cameroon, in 2006

Input	Equipment unit cost (US$)	Equipement life span (years)	Utilization period	Equipment depreciation (US$)	Total costs (US$)
Fixed costs					
Hoes	2.6	3	1	0.6	0.6
Cutlass	3.0	3	1	0.3	0.3
Auger	5.0	5	1	0.3	0.3
Buckets	3.0	2	1	1.2	1.2
Baskets	0.6	1	1	0.6	0.6
Carrier	100	10	1	10	10
Drums	20	10	1	2	2
Total fixed costs					**15**
Variable costs					
Labour	80				80
Pump hiring	40				40
Total variable costs	**120**				**120**
Total costs					**135**
Total sales revenue[1]					**2 400**
Profit (US$)					**2 265**

[1] Catfish fingerlings are sold between US$0.05 to US$0.2 per unit.

FISH FEED

Catfish aquaculture producers in Cameroon do not depend on wild-caught feed. Weeds, household organic refuse and, to a lesser extent, agro-industrial by-products such as oilcakes, wheat and rice bran, etc., are generally used to feed the catfish. Single feed ingredients used to feed catfish fingerlings compete with other domestic animals, such as pigs and poultry. These feeds consist of wheat bran and miscellaneous oilcakes, which are mostly farm-made or, to a lesser extent, purchased (Pouomogne, 2007a).

ENVIRONMENTAL IMPACTS OF THE SEED FISHERY

Fingerling collection for aquaculture is usually performed in lowlands inside farm plots after flooding has started to subside. To date, no negative reports, formal or informal, have indicated any decline in the wild stock. Nonetheless, as the wild stock itself is an important local food commodity, adequate fishery statistics need to be collected and monitored systematically to ensure that there is no impact on the stocks as a result of collecting wild catfish juveniles.

Over 95 percent of the fish catch in the Nkam Valley consists of the local catfish species, *Clarias jaensis* (80 percent), followed by the introduced *Clarias gariepinus* (20 percent). Tilapia and the exotic snakehead, *Parachanna obscura,* are among the principal non-target species recorded in the catch data. At Lelem, one fisher reported a recent progressive increase in the percentage of *Parachanna* in his catch indicating that the population dynamics of native species may need further investigation.

No prohibited fishing methods (e.g. fire, poisons, explosives) have been observed in the valley. Foreign commercial fishers using unsustainable fishing gears (e.g. the cast-net "gourah" of Malians, or the beach seine "taro" of the Ghanaians) or extreme levels of fishing intensity have not been observed in the Nkam fishery.

The key strategy for protection of the environment appears to be the full involvement of native fishers in resource management. In the case of the Nkam Valley, ancestral knowledge of the Mbô people, in addition to the national law providing priority in land ownership rights to natives, somewhat guarantees a management control over the fishery resource.

SOCIAL AND ECONOMIC IMPACTS OF FARMING

In each Santchou extended fishing family there are an average of five fingerling collectors and two flood pond fish farmers. The collection of juvenile catfish constitutes a marginal occupation; however, 50 percent of fishers have links with fish farmers outside of the valley and derive substantial income from selling fingerlings. Tradition and pleasure were stated as the motivations for being involved in fingerling collection or fish farming.

Besides fishing, farmers engage in other economic activities such as crop production, animal husbandry, trading and teaching. Fingerling collection and fish harvesting are performed during the dry season (November–March) along with cocoa and coffee harvesting and farm land preparation. Fishing and aquaculture activities are thus a secondary occupation after agriculture and land animal husbandry.

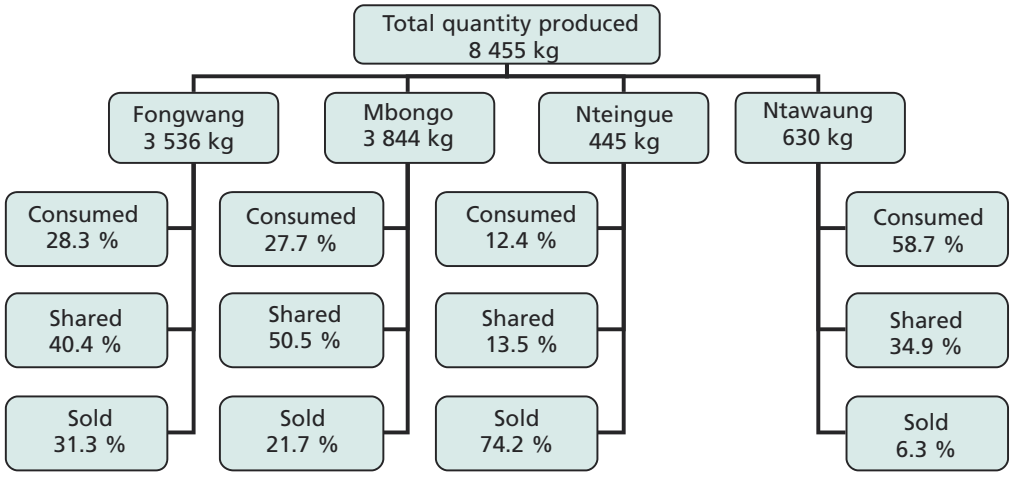
Most fishers are male (>85 percent), literate (>75 percent attended primary school), and married (70 percent), with an average of eight people living in the house.

Che (2007) documented catfish production from flood ponds in several villages in the Nkam Valley in 2006. The total quantity harvested was 8 455 kilograms which were used as follows (Figure 6):

- direct consumption by the family (31 percent);
- gifts to relatives and friends (34 percent); and
- sale on the market (35 percent).

According to fishers, fish constitutes a major source of protein for the family. Sharing the catch with relative promotes love and friendship among the farmers. Selling

FIGURE 6
Harvested fish flow from four villages in the Nkam Valley



Source: Che, 2007.

fish for cash increases household incomes and serves to help satisfy demand from other consumers.

Before the emergence of a market for fingerlings outside of the valley, fish were caught for bait, stocking of flood ponds or for direct human consumption. Fish in excess of what could be immediately consumed were often smoked for later utilization. Juveniles were often sold as human food at an estimated price of US$0.8 per kilogram fresh weight fish. At 25 grams average weight, this is equivalent to US$0.02 per fingerling.

With the competition introduced by outside buyers, the unit price is currently much higher (up to US$0.25 for *Clarias gariepinus*). Catfish collectors and dealers are being requested to separate the two catfish species (and to select *Clarias gariepinus*); to grade fish into homogenous sizes; to improve live fish handling and transportation techniques; and to hold fingerlings for sale outside of the wild-capture season. Since the literacy level among fishers is good, most of these challenges are likely to be met.

Traditional annual festivities are organized to pay tribute to the gods of the valley who benevolently provide fishery resources to the Mbô. This special relationship with their gods strongly encourages the Mbô to protect the aquatic environment, limiting catches and designating certain areas within the valley as sacred and not to be fished or farmed.

To address the market demands mentioned above, fishers have gathered into groups and requested technical and financial support from the authorities and from the donor community. One of the activities of the CIP project (see Annex 1) is to train farmers to increase their profitability from the fishing activity. One group of farmer groups (Pêcheurs Et Pisciculteurs De Santchou – PEPISA), has recently overseen the training of six fingerling collectors who are now capable of sorting fish into species and sizes classes.

The case study of four villages illustrates the social issues and income generated from the *Clarias* fishery in the Nkam Valley (Che, 2007):

i) One of the objectives of the fish farmers in these villages is to have good quality fresh fish for home consumption. The fish consumed by an average fish farmer is almost 10 times the maximum quantity consumed by rural fish farmers in Yaoundé (8.3 kg) (Brummett, 2005; Brummett, Pouomogne and Gokowsky, 2007). The total annual fish consumed in the villages has been estimated at >30 percent of the total quantity of fish produced.

FIGURE 7
Sale of fresh catfish at home (left) or ready for smoking (right)

COURTESY OF D. MFOSSA

ii) An important part of the fish produced is donated as gifts (34 percent). Fishers explain that sharing strengthens relationships between friends and family members. In Santchou, the fish are shared either fresh (10 percent) or smoked (90 percent).

iii) The selling of fish immediately after harvest is either at the fish farmer's house (>57 percent) (Figure 7), along the road (24 percent) or at the market. Information concerning the harvest and selling of fish is usually communicated verbally to friends and neighbours and to more distant households by sending children with fish to circulate in the area so that people will see and ask where they can buy more. Some of these buyers place their orders before the farmer harvests the fish. In case the fish destined for sale is not all purchased, the remaining fish are prepared for preservation through smoking. The buyers of the fish are restaurant owners, mostly women, retailers and housewives.

Over 28 percent of fish farmers sell fish on a weighing scale, while most sell the fish in heaps or strung on ropes. The prices of fish currently vary between US$1.00 and US$2.4 per kilogram (Table 6).

TABLE 6
Fish prices along the chain of custody

	Market location		
	Market	House	Road
Minimum price of fish (US$/kg)	0.5	0.6	0.7
Maximum price of fish (US$/kg)	2.4	2.0	2.4
Average price (US$/kg)	1.46	1.31	1.62

Source: Che, 2007.

The price for pond fish ranges from US$1.0 to 1.6 per kilogram, with most purchased at the lower end of the scale (Table 7). Demand is thus relatively inelastic as fish are perceived as an inferior good, which is mainly consumed in low income households. The average price of fish is higher when it is sold along the road in comparison to those sold in the farmer's house or at the market.

TABLE 7
Prices and quantities of pond fish sold in the Nkam Valley

Fish price (US$/kg)	Quantity purchased (kg)
1.0	1549
1.2	760
1.6	600
2.0	90
2.4	10

Source: Che, 2007.

Over the four month season, an individual fingerling collector distributes an average of 11 700 juveniles for a total revenue of US$1 630.

Although fish collection is a seasonal and secondary activity, after agriculture and animal

husbandry, it can be economically attractive compared to other activities if sustainability managed. Expectations of the farmers are high particularly if they receive training on how best to keep juvenile *Clarias* alive to supply buyers outside the fishing season.

MANAGEMENT AND LEGISLATION

The main laws dealing with the aquatic ecosystems in Cameroon are: Law N° 94/01 of 20 January 1994 on the exploitation and the management of forests, wildlife and fisheries, and Law N° 96/12 of 5 August 1996 on the management of the environment. The preamble of the fundamental law N° 96–06 of 18 January 1996 consecrates the rights of native minorities within their homeland. Together these regulation schemes, if strictly applied, strongly support sustainable management of isolated fisheries, such as the catfish resources of the Nkam Valley. The introduction of alien species (between river basins and from abroad), fishing gear, pollution prevention and other fishery management strategies are dealt with in the existing legislation. A new and revised set of laws to bring the legislation into line with the FAO Code of Conduct for Responsible Fishing (CCRF) is currently under development. This will reinforce the role of research and co-management of fisheries resources, committing the main actors to use available scientific information to improve management of both national and transboundry fisheries (Pouomogne, 2006). Lessons learned in the Nkam Valley (Vander Stuyft and Essomba, 2005; Pouomogne and Mikolasek, 2007) also have relevance to management approaches based on native rights and indigenous knowledge reported in Thailand for the Bangkhen fish culture, Niger in the Tafouka flood ponds and in the Benin whedoes on the Oueme river (Muanboong, 1981; Mikolasek, Mahaman and Siddo, 1998; Imorou *et al.,* 2007).

CONCLUSION

The use of wild-caught *Clarias* catfish for aquaculture purposes is an ancestral practice of the Mbô people in the Nkam Valley. Over the past 10 years, the demand for this seed material outside the valley has created new market opportunities and has led to various *Clarias* resource management modifications in the valley. In 2006, about 0.5 million seed were caught and used for aquaculture, of which about one tenth was exported out of the valley. The main targeted aquaculture species, *Clarias gariepinus*, is second in abundance in the wild after the native *Clarias jaensis*. The Mbô ethnic group have strong regards in the preservation of the fishery resources and have demonstrated instinctive conservation behaviour for the catfish resources. The farmers remain poor but are convinced that they could benefit more from this natural resource.

Research, such as that conducted by the CIP project, may improve the sustainable use of catfish resources in the valley. This programme is based on a better biophysical and socio-technical knowledge of the people and resource which will hopefully lead to improved co-management of the resources (Pouomogne *et al.*, 2006). However, more training of fishers is needed particularly in the handling of wild caught fish to improve quality and survival of fingerlings destined for aquaculture. Most of fishers are poor and unable to implement sustainable management schemes. Adequate credit facilities are necessary to facilitate the purchase of basic fish collection and transportation equipment as well as the construction of short-term holding infrastructure. Due to the strong ethnological and religious links with the aquatic milieu of the Mbô people, legislation reinforcing and protecting their rights may constitute a good strategy to conserve and manage the fishery resource.

ACKNOWLEDGEMENTS

Much of the data presented in this report were gathered within the frame of the CIP project. All agro-fishers of the Nkam Valley who contributed information are warmly thanked. Dr Randall Brummett of the WorldFish Center provided comments on the manuscript.

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ANNEX 1

The CIP project – Building Innovation in Fish Farming

The main objective of this project is to build through a partnership approach with small-scale farmers a sustainable model of commercial fish farming. The paradigm of this approach highlights local socio-cultural features of the partners involved in the process, alongside with the systemic and complex agronomic knowledge that is needed to fully appraise the diversity of this tropical ecosystem.

The project started in 2004 with a diagnosis survey of fish farming in Menoua division, Western Cameroon Highlands, using a funding of the "Pôle de Compétence en Partenariat-Grand Sud Cameroun" (PCP-GSC). This pole of excellence is constituted of the following partners: IRAD, University of Dschang, University of Yaounde 1, and CIRAD. Following the diagnosis, further funds from CIRAD and the French cooperation allowed to build an action research scheme to address the problems identified. This scheme consists of a research team from the above listed institutions, and two groups of farmers namely "Collectif des Pisciculteurs Intensifs de Fokoué et Penka Michel", (COPIFOPEM) and "PEcheurs et PIsciculteurs de SAntchou" (PEPISA). Key questions addressed by the team are the followings: (i) how to supply fingerlings and make fish farming a sustainable commercial activity at Fokoué; and (ii) how to improve the capture of wild catfish seed and increase financial gains from capture-based aquaculture at Santchou?

A dozen of scientists and postgraduate students are currently involved in this research programme in cooperation with CIFORD, a non-governmental organization, based at Bafoussam, Western Cameroon. Three senior scientists and two farmers' leaders are animating the research team, namely Dr Victor Pouomogne, Dr Olivier Mikolasek, Dr Minette Tomedi Eyango Tabi, Mr Tila Antoine and Mr Essang Narcisse.