Aquaculture in The Gambia

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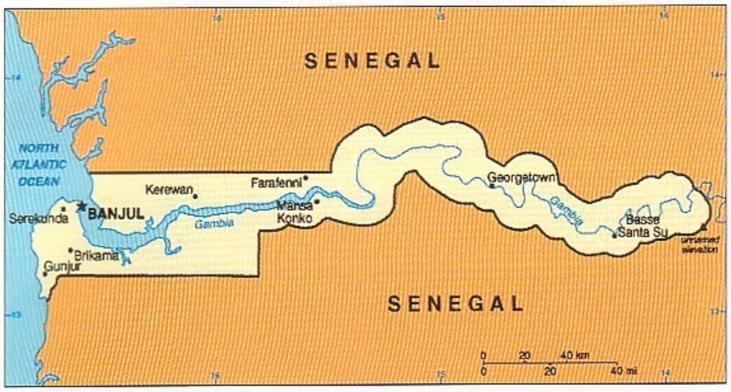

Fig. 1. Map of The Gambia showing major cities and towns and the Gambia River that completely bisects the country (CIA 2011).

Historically a Portuguese and then a British colony, The Gambia (or simply Gambia), with a population of about 1.7 million, is in the Sahelian Upwelling Marine Ecoregion and has about 70 km of coastline along the Atlantic Ocean. Gambia's Exclusive Economic Zone extends 200 nautical miles from the low water mark and covers about 5,000 km^2 of continental shelf area. With a land area of 11,295 km^2, it is the smallest country on continental Africa ranging from about 30 to 50 km in width along the banks of the Gambia River, but stretching about 450 km inland. English is the official language, but the country is surrounded by francophone Senegal on all sides except for the west coast on the Atlantic Ocean.

The country consists of roughly three geographic regions, including a lower river region on the coastal plain where the river is generally brackish and tidally influenced inland for about 200 km. The central river region east of Mansa Konko is mostly freshwater during the dry season but also tidally influenced. The tidal amplitude is less than in the lower estuarine portion of the river. There is a non-tidal freshwater upper river region beginning several kilometers east of Georgetown (Janjangbure), where the river channel becomes shallow and more difficult to navigate (Figure 1).

Climatologically Gambia experiences a tropical dry season – wet season precipitation pattern, with most of the 990 mm average annual rainfall occurring between July and September. The central river region is the major grain production center of the country with irrigated paddy farming of rice but production is insufficient to meet national demand. Rice is the most important cereal grain consumed domestically and Gambia is a net importer of all of its cereal grains, including rice.

Major exports of the country include peanuts (groundnuts), fish, cotton, copra and palm oils. Banjul, the capital city located on the coast, hosts the largest fish landing port and the country's sole deepwater seaport and nearby international airport with international flights to neighboring African countries and the European Union (CIA 2011).

According to statistics from the Gambian Department of Fisheries, the Gambian people consume approximately 25 kg of fish and other seafood products per capita annually, nearly double the world average, making up some 70 percent of the animal protein consumed by Gambians (Jallow 2008, FAO 2011). Fisheries resources are provided primarily from two sources, the Gambia River and the Atlantic Ocean. The maximum sustainable yield (MSY) of fisheries in all Gambian waters has been estimated by the Gambian Department of Fisheries to be about 80,000 t for all fish species, while the current fishery catches have fluctuated between 31,000 and 45,000 t annually in recent years between 1997 and 2009 (FAO 2011). The overwhelming majority of fish production in Gambia is from wild capture fisheries and the gap between current catch and MSY suggests the possibility of some growth in the capture fisheries sector.

Despite an average consumption of about 25 kg of fish per year, the distribution and availability of fish is not uniform throughout the country. The vast bulk of fisheries landings occur in the lower river estuarine portion of the Gambia River and along the coast. Transport of fish to interior markets within the country is hampered by inadequate ice-making capacity and lack of refrigerated trucking, so simple methods of salting and smoking are used to preserve fish to allow inland transport. But these simple fish preservation methods reduce the market desirability of fish locally. Additionally the freshwater zones of the central and upper river regions are overfished, leading to local fish shortages, so the Gambian Department of Fisheries estimates that annual per capita fish consumption in the interior regions of Gambia is only about 9 kg, well below national and global averages (Gambia Department of Fisheries 2010).

Freshwater Aquaculture

Given the prominence of fish and other seafood in Gambian diets, there have been some efforts to introduce aquaculture. The introduction of freshwater aquaculture to Gambia occurred during the late 1970s and early 1980s through collaboration between the Gambian Department of Fisheries, Catholic Relief Services, and the United States Peace Corps, focusing largely on the introduction of small-scale tilapia farming to small villages along freshwater portions of the river. This effort was short-lived but provided practical experience for Gambian fisheries officials who participated in subsequent efforts to culture tilapia and other freshwater fish (Jallow 2009). Problems with these initial projects included poor site selection, with ponds that were built on leaky laterite soils, and an unwillingness to co-opt space from rice farmers, a crop that was considered by many to be more profitable.[4]

Fig. 2. Water supply and drainage canal for Sapu tilapia ponds. Photo by Famara Darboe.

Fig. 3. Manual soil compactors constructed with sticks held in concrete poured into 4-L metal cans. Photo by Famara Darboe.

Renewed interest in freshwater aquaculture began in 2008 with a UN-FAO sponsored review of fisheries regulations that recommended more stringent enforcement and penalties for illegal fishing, particularly in the upper freshwater reaches of the Gambia River. Additionally technical assistance to establish freshwater aquaculture was provided to the Gambian Department of Fisheries and the Department of Agriculture by the Taiwan Technical Mission. A number of factors, including the relatively low availability and consumption of fish in the inland areas of Gambia, also make revival of efforts to introduce freshwater fish culture an attractive prospect. Several species of cichlid fish (mostly tilapias) are native to the Gambia River and are easily cultured. In addition to tilapias, other available species amenable to culture include the African catfish, *Clarias gariepinus*; the African arowana, *Heterotis niloticus*; and the African knife fish, *Gymnarchus niloticus*. The Gambian Department of Agriculture maintains a series of demonstration rice farms at Jahili-Medina near the village of Sapu (13.546°N, 14.894°W) that are irrigated by waters from the Gambia River. This region is Gambia's premier rice producing region because the Gambia River there is freshwater year-round and there is enough tidal amplitude to allow periodic flooding of fields (Snead 1967). Construction of fishponds then became simply a modification of existing rice paddies using techniques introduced from Taiwan.

With major funding provided by a Technical Cooperation Program grant from the UN-FAO, site selection was undertaken in March 2009 with attention to soil type and determination of proper elevation for a water supply canal (Figure 2). Construction of 20 ponds began in April 2010 and pond bottoms were excavated to an elevation 1.0 to 1.3 meters below the spring high water level to allow for pond filling. To assure proper gravity drainage, pond bottoms are above the low spring water tidal level. Ponds are roughly 340 m^2 in area (about 25 m x 13.5 m). Due to characteristic heavy seasonal rainfall during July, August and September, dikes were constructed with adequate height using soil excavated from pond bottoms, resulting in a freeboard of about 70 cm, a dike crest width of 60 cm, and base width of 300 cm. As dikes were being constructed, fish farmers used hand-made manual soil compactors to assure that each soil layer was adequately compacted (Figure 3).

Water is supplied to all ponds through a pre-existing tidal canal first constructed for rice paddy irrigation. The supply canal draws water directly from the Gambia River and flow is controlled by a main sluice gate. Water supply and drainage of each pond is by a concrete monk drain system at the deepest part of the pond nearest to the water supply and drain pipe traversing the water supply canal dike. As part of the system to protect dike integrity, emergency spillways are provided to allow rapid drainage of water during the rainy season. Shallow-rooted creeping vegetation was encouraged to grow on the dikes to minimize erosion (Figure 4).

When ponds were built, broodstock of Nile tilapia *Oreochromis niloticus* captured from the wild were stocked into a designated spawning pond (Jallow 2011a). Each of the remaining 19 production ponds was stocked with about 10,000 fish per pond and fed a locally produced diet consisting of rice bran, peanut cake, wheat flour, locally sourced fish meal, a vitamin mix, salt, and palm oil that is extruded into pellets and sun dried. Fish ponds are maintained by local farmers from Sapu and fish are sold when harvested. Part of the training for fish farmers of Sapu is in the use of hapa nets for isolating and maintaining broodfish (Figure 5). As of mid-2011 all tilapia production from ponds is being sold or consumed locally in the Sapu area.

In addition to the newly established tilapia farm in Sapu, a farm in the village of Kanilai (13.178°N, 16.005°W) has been growing Nile tilapia since 2004 as part of the agricultural operations of Gambian President Yahya Jammeh. No details about production from the farm are available but fish are marketed locally.

Shrimp Farming

Shrimp farming was introduced to Gambia in 1982 with the establishment of a 200-ha semi-intensive farm complex by the Norwegian-financed Scan-Gambia Shrimp, Ltd. on the south bank of the lower estuary portion of the Gambia River near the town of Pirang (13.283°N, 16.526°W) (Figure 6). The farm was designed to have a pumping capacity of 250 m^3 per minute and include a hatchery with a capacity of 10 million PLs per month and a certified processing facility with offices, stores, workshops, freezer, cold storage and an ice plant to enable export of shrimp to Europe (Sadek *et al.* 2002). The farm began production operations in 1988 with the importation of giant tiger prawn (*Penaeus monodon*) broodstock from Asia. In 1989 and 1990, production was about 50 mt (FAO 2011).

Scan-Gambia ceased operations in 1992 due to financial problems (Jallow 2009), but in 2000 the assets of Scan-Gambia, including ponds, hatchery and processing facility, were acquired by a group of local Gambian investors and reincorporated as West Africa Aquaculture, Ltd. (WAAq). The WAAq group operated the farm using about 50 ha of the 200 ha that was originally constructed, and production amounted to only about 25 t annually, suggesting that the company was severely undercapitalized.[5] Although the farm originally intended to supply export markets, most of the *P. monodon* shrimp produced was marketed locally to tourist-class hotels and restaurants. WAAq ceased farm operations in 2008 due to financial problems. The Gambian National Assembly has raised concern about the farm co-opting valuable artisanal fishing grounds in wetlands adjacent to the Gambia River, but not generating any economic activity in return.

Fig 4. Tilapia pond at Sapu showing monk drain at deepest end of the pond and the emergency spillway at the shallow end of the ponds spilling into a shallow drainage canal. Photo by Famara Darboe.

Fig. 5. Hapa nets set up in a fishpond to hold broodstock. Photo by Famara Darboe.

Fig. 6. Satellite image of the Gambian shrimp farm at Pirang taken June 7, 2004 while the farm was being operated by West African Aquaculture, Ltd. The Gambia River is at the top of the image. Only about 50 ha of the designed total 210 ha farm was in use for shrimp farming. Image by Google Earth.

Culture of Bivalve Mollusks

The wild harvest of molluscan shellfish in Gambian estuaries is most often the work of women fishers. Mangrove oysters *Crassostrea tulipa* (*C. gasar*) are collected mainly from mangroves in the lower Gambia River estuary. The vast bulk of oyster harvesting occurs in the Tanbi Wetlands, a mangrove-dominated wetland complex south and west of Banjul along the Atlantic coast. The oyster season is normally from March to June, until the onset of the five-month rainy season. Greatest spatfall occurs during

October and November, toward the end of the rainy season, and farmers allow about eight months for oysters to grow to market size before harvesting begins in March. Oysters are generally marketed as shucked meats in small stalls along main roads near the estuary or in local fish markets.

Another shellfishery with participants that are primarily women is the fishery for the common West African blood ark clam *Senilia (Anadara) senilis*, known locally as cockles. Cockles are harvested throughout the year with the exception of the summer rainy season. Cockles are generally harvested by hand in sandy bottom estuaries along the Atlantic coast. Cockles are most frequently cooked whole to open the shells and sold in local markets as a cooked product.

With both oyster and cockle harvesters, shells form the basis of a secondary income source when used as a feedstock in the artisanal manufacture of lime or alternatively sold and crushed as an additive for poultry feed. However, piles of oyster shells are found at all oyster processing sites near Tanbi because fuelwood for lime production is unsustainably managed and market demand for shells is far less than supply. In some areas of the upper estuary where the supply of oyster shells is less and fuelwood is abundant, lime production is a vibrant secondary industry to oyster farming (Figure 7).

Fig. 7. Small-scale lime production operation in Kartong, Gambia. Empty shells of locally harvested blood ark clams are burnt using wood fires to manufacture lime for masonry mortar and other uses. Photo by Michael A. Rice.

Fig. 8. Spat collector consisting of strings of ceramic tiles suspended from horizontal bamboo poles in the Tambi estuary. This photo taken mid-June 2009 shows considerable fouling by tunicates of the genus Mogula. Photo by Michael A. Rice.

Early on, the Gambian Department of Fisheries recognized the potential of molluscan aquaculture as an economic development tool for the Gambia. During the late 1980s, experiments with the culture of mangrove oysters *Crassostrea tulipa* (*C. gasar*) were begun as a collaborative project between the Gambian Department of Fisheries and Dr. Gary Newkirk of the Mollusc Culture Network at Dalhousie University, with funding from the International Development Research Centre (IDRC) of Canada. The project focused on using oyster culture technology developed in Jamaica where mangrove poles were used as spat collectors (Henderson 1994). Despite this effort, the harvest of wild oysters from mangrove roots, mostly in the Tanbi Estuary near Banjul, provided a sufficient supply to satisfy existing market demand, so this effort also failed to establish oyster farming in the country (Jallow 2009).

Since 2009, there has been renewed interest in the culture of shellfish in Gambia. In recognition that the domestic market for oysters in Gambia is rather modest and prices obtained for shucked oyster meats are low (typically 50 Gambian Dalasis or about US$2/kg), effort has been applied to the development of a shellfish sanitation program based on U.S. Interstate Shellfish Sanitation Conference (ISSC) or European Union standards (Jallow 2011b). The primary aim is to boost domestic and international confidence in the sanitary quality of oysters and other shellfish grown in Gambian waters, thereby increasing demand for these products. During the dry season, many of the oyster growing areas in the Tanbi estuary would be classified as acceptable using the 70 MPN per 100 mL or 14 MPN per100 mL total coliform water quality standard of the ISSC (ISSC 2009).

Efforts are also underway to use artificial oyster spat collectors to determine the location and timing of oyster spatfall and settlement of fouling organisms in oyster harvesting grounds of the Tanbi wetlands area near metropolitan Banjul. Preliminary data suggest that the primary period of oyster spatfall in the Tanbi wetlands is toward the end of the annual rainy season in September. Heaviest spatfall occurs in the southern portion of the Tanbi wetlands that remain less saline for longer periods of time than more northwesterly regions of the wetlands. Heaviest recruitment of fouling organisms on spat collectors occurs in May and June at the end of the seven-month dry season (Figure 8).

Pilot experiments are underway to incorporate simple aquaculture methods into the daily work activity of women engaged in oyster harvesting. During the early part of the oyster harvesting season, larger oysters of marketable size are mixed among smaller oysters that are typically discarded during the oyster harvest. Rather than simply discarding the juvenile oysters as wasted bycatch, fishers are encouraged to place smaller oysters into a floating basket cage constructed of locally available materials (Figure 9). The study will evaluate if culled oysters will grow to market size in floating gear and if the practice is economically feasible given the relatively low prices of oysters. Aquaculture might provide a more convenient supply of oysters as the season progresses because oyster harvesters are normally forced to travel farther as nearby market-sized oysters become locally depleted.

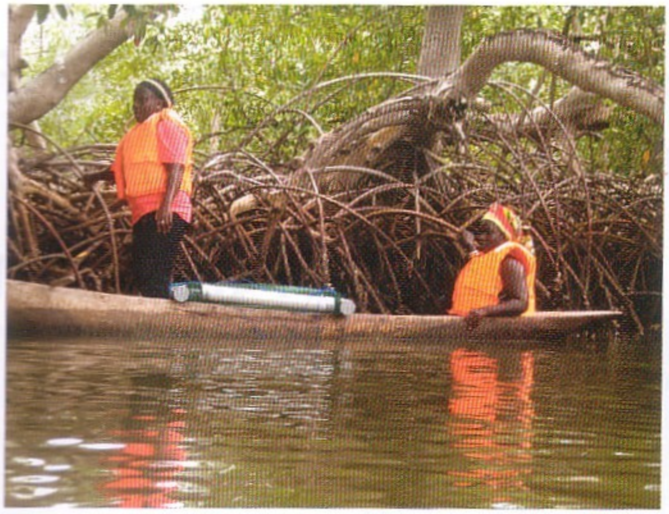

Fig. 9. Gambian oyster fishers deploying experimental oyster culture float near their preferred fishing grounds at Kubuneh, Gambia. Photo by Emily Nichols.

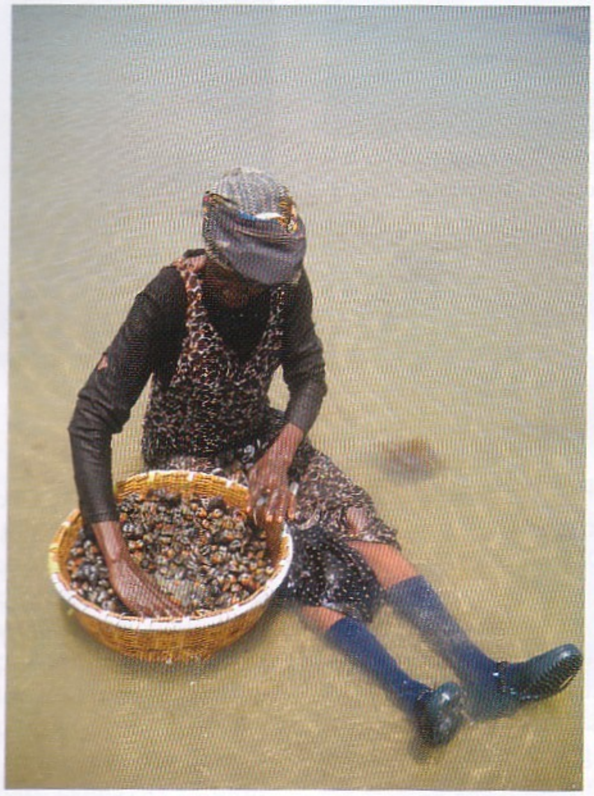

Fig. 10. Woman clam farmer of Kartong with juvenile blood ark clams Senelia senilis *to be seeded into prepared intertidal aquaculture plot. Photo by Casey Donohue.*

Other pilot experiments are underway to incorporate simple aquaculture methods into the daily routines of women who fish for cockles following some of the procedures long used to grow blood ark clams *Anadara granosa* in Malaysia (Tookwinas 1983, Broom 1985). Cockle harvesters in the village of Kartong on the southern border of Gambia near southern Senegal have selected an intertidal sand flat, prepared the site by raking to remove predators, and seeded the flat (10 cockles/m^2) with small (<10 cm) *Senilia senilis* seed from adjacent seed beds in the Kartong Estuary (Figure 10). Information on growth and post-transplant mortality is being collected by the fishers and a U.S. Peace Corps volunteer assigned to assist the women with the project. The cockle-harvesting women of Kartong have noticed that that seed densities for *S. senilis* are very high in the estuary and there is considerable mortality of seed before they reach about 10 cm in shell length, presumably caused by crowding.

Conclusion

Aquaculture in Gambia is very much in its infant stage, but it holds great promise because the Gambian people value seafood in their diets and there appears to be general support by both the government and the public for fish and shellfish farming. Major constraints to aquaculture in Gambia appear to be scarce and expensive access to capital, relatively poor transportation and shipping infrastructure in the country and in the case of shellfish, relatively low market prices that make gear acquisition relatively expensive in relationship to the value of the cultured crop. The forms of artisanal aquaculture that appear to hold the most promise for the country are those that can be incorporated into the regular routines of existing rice farmers, in the case of aquaculture of tilapia and other freshwater fish, or the routines of existing shellfishers, in the case of oysters and cockles. Although aquaculture is considered favorably by the Gambian government for its potential to build a Gambian export trade portfolio, the history of the faltering shrimp aquaculture in the country over almost three decades suggests that a number of barriers to business success remain in place.

Notes

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[4]Based upon an unpublished 1981 manuscript "Fish Culture in the Gambia: Assessment of Problems and a Project Proposal" by Daniel Theisen, Crane

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[5]Feed purchases in 2007 (the last year of WAAq operations) amounted to 1,512 bags of feed at 25 kg/bag. Assuming a favorable FCR of 1.5, this is equivalent to about 25 mt of shrimp harvested.

[6]A complaint was filed 20 July 2010 in the United States Federal Court, Central District of Pennsylvania, *West Africa Aquaculture, Ltd. v. Zeigler Bros., Inc.* Case number: 1:2010cv01490, alleging breach of contract in the improper replacement of melamine-contaminated feeds sold to the plaintiff. WAAq was seeking compensation of US$37,500 for alleged direct monetary loss associated with the bad feed and additional compensation for the loss of the entire 2007 shrimp crop.

[7]Personal communication to M.A. Rice and O. Drammeh by Hon. Amadou Bojang, Speaker of the Gambian National Assembly, 23 June 2011.

[8]Water quality data in the Tanbi estuary collected and analyzed by the Water Resources Laboratory, Department of Water Resources, Abuko, Gambia.

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