Status of Aquaculture in the Zanzibar Islands, Tanzania

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Aquaculture in the Zanzibar Islands of Tanzania (Fig. 1) takes place mainly in the marine environment. The main types of farmed organisms are seaweed (*Eucheuma denticulatum*, *Kappaphycus striatum*, and *Kappaphycus alvarezii*), marine finfish (milkfish *Chanos chanos* and mullet *Mugil cephalus*), bivalve shellfish (pearl oyster *Pinctada martensii, P. margaritifera, Pteria penguin, Isognomon,* and *Anadara* spp.), crabs (mangrove crab *Scylla serrata*), sea cucumbers (*Holothuria scabra, Actinopyga mauritiana, A. miliaris*), and tilapia farmed in seawater. The greatest aquaculture production in Zanzibar is of seaweed, followed by finfish.

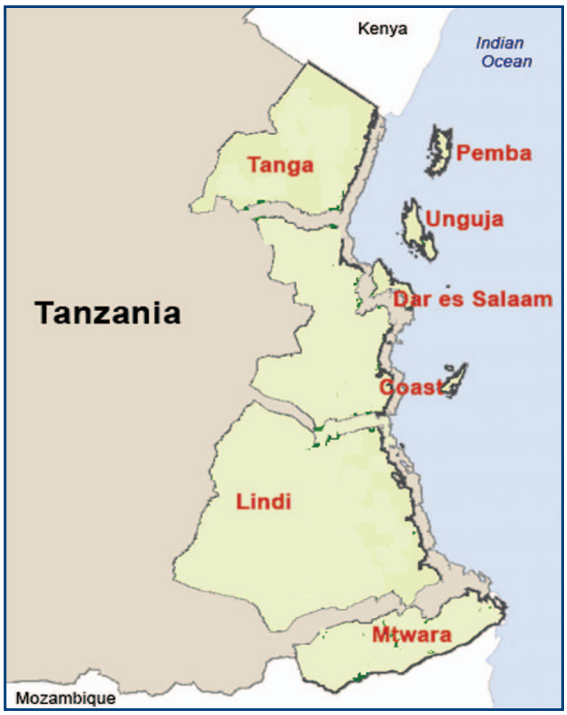

FIGURE 1. *Map of Tanzanian coast showing aquaculture sites.*

Historical Perspective

Seaweed has been farmed commercially since 1989. Commercial farming was preceded by studies on the potential of seaweed farming during the 1970s, followed by experimental farming in the early 1980s (Mshigeni 1976, 1992). In 1990, the first exports of dry seaweed (808 t) from Zanzibar occurred. Production has been increasing since then and by 2014 production was 13,000 t.

Finfish mariculture started in the 1980s with a study of rabbitfish cage culture. In 1996, experiments were conducted by the Institute of Marine Sciences (IMS), working with several partners, using earthen ponds. The 1996 experiments culminated in establishment of the first finfish-shellfish-seaweed integrated system in Makoba Bay, north of Zanzibar town, and formulation of the first marine fish feed (Mmochi *et al*. 2001). Species used then were finfish (rabbitfish *Siganus* and later milkfish *Chanos chanos*), shellfish (*Anadara antiquata*); and seaweeds (*Eucheuma denticulatum*, *Kappaphycus alvarezii*, *Gracilaria crassa*, *Ulva* spp., *Chaetomorpha crassa*, and *Codium* sp.). Following the establishment of the integrated system, several multidisciplinary studies were conducted using the integrated system, including an investigation of environmental and pesticide issues (Mmochi and Mwandya 2003, Mmochi *et al*. 2002), live food (Kyewalyanga 2003, Kyewalyanga and Mwandya 2002), and seaweed (Msuya and Neori 2002, Msuya *et al*. 2006). Shellfish farming that started in 1996 in the IMS integrated system expanded to reach some villages in Unguja and Pemba. Crab fattening started in the 1990s and sea cucumber farming around 2010. Unlike other forms of aquaculture, commercial seaweed farming started much earlier and, therefore, the experiments on integrating seaweed and fish were a step forward by the industry.

Netting threaded with seaweed seedlings.

Current Situation

Seaweed

Seaweed species farmed in Zanzibar in order of production are *Eucheuma denticulatum*, *Kappaphycus striatum*, and *Kappaphycus alvarezii*. The number of farmers, number of villages farming seaweed and production differ between the two islands. Pemba, with a population of 406,808 according to the 2012 census, has more farmers and greater production than Unguja, with a population of 896,721 although the number of villages that farm seaweed is less (Table 1). Similarly, the number of women farmers differs between the two islands.

The number of villages farming seaweed in Pemba is less than in Unguja but the number of farmers is more than double that in Unguja (Table 1). In Unguja, the proportion of farmers that are women is 93 percent whereas in Pemba the proportion is 36 percent, reflecting differences between the two islands. The reason for fewer men farmers in Unguja than Pemba is that men in Unguja have more alternative job opportunities related to the more developed

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TABLE 1. NUMBER OF VILLAGES FARMING SEAWEED, NUMBER OF FARMERS, AND SEAWEED PRODUCTION FOR ZANZIBAR, 2012.

	Unguja (Population 896,721)	*Pemba (Population 406,808)*	*Total*
Number of villages	50	33	83
Number of farmers	8,699	14,072	22,771
Production (t)	1,172	12,005	13,177
% Production	8.9	91.1	100
Number and percent of farmers by sex, Zanzibar, Tanzania			
Unguja a.k.a Zanzibar			
	Women	*Men*	*Total*
No.	8,094	605	8,699
%	93	7	100
Pemba			
	Women	*Men*	*Total*
No.	5,090	8,982	14,072
%	36	64	100
Total farmers for both Islands			
No.	13,184	8,982	22,166
%	59	41	100

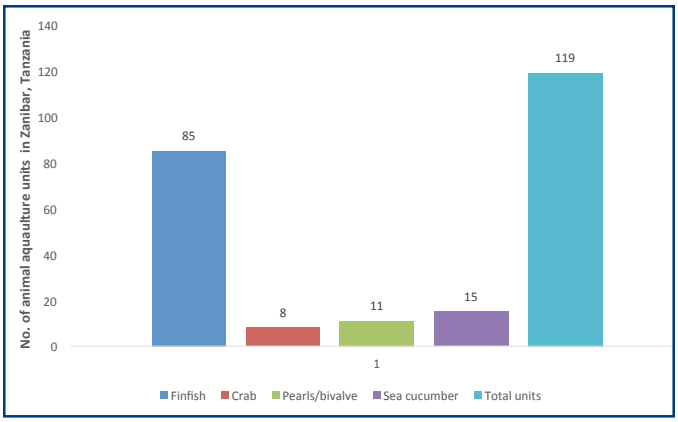

FIGURE 2. *Number of animal aquaculture farmer units in Zanzibar, Tanzania for 2012.*

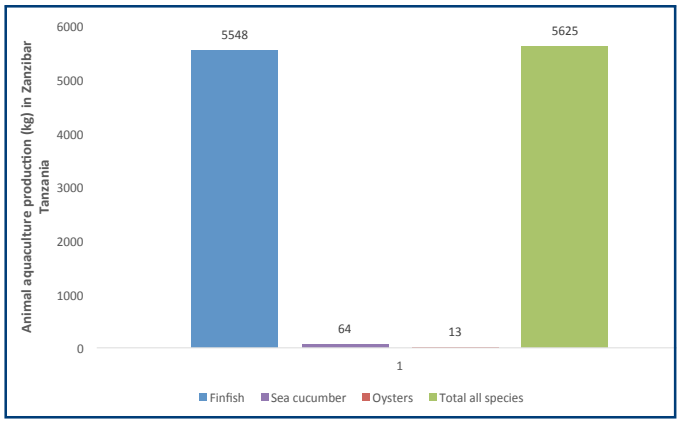

FIGURE 3. *Animal aquaculture production (kg) in Zanzibar, Tanzania for 2012.*

tourism industry compared with Pemba (Msuya and Porter 2014, Msuya 2011). Taking both islands together, 60 percent of seaweed farmers are women and 40 percent are men. Production in 2014 was 13,097 t for both islands but Pemba produces more than 90 percent of the total production. Seaweed in Zanzibar is farmed using shallow-water off-bottom methods but there have been experimental trials using deepwater farming methods (Valderrama *et al*. 2015).

Finfish

Finfish farming is the dominant animal aquaculture in Zanzibar surpassing other animals by the number of groups engaged in mariculture (referred to as "farmer units" in this article) and production. Between 2006 and 2008 finfish farming was still at an experimental stages (Requintina *et al*. 2008, Rice *et al*. 2006), but has in more recent years expanded primarily after private business people became interested in farming. Efforts have also been made to provide training on pond construction, which was identified as one of the challenges for finfish farming in 2008. Currently finfish species farmed in Zanzibar are milkfish *Chanos chanos*, mullet *Mugil cephalus*, and more recently tilapia. The number of farmer units is 85 (Fig. 2) with more in Pemba (71) than Unguja (14). Production of finfish in 2012 was about 5.5 t, valued at US$ 7,600 for both islands. Most fish production is from earthen ponds reconstructed primarily from saltpans with a farming period of six months from stocking to harvesting. Seed is collected from the wild or purchased from fishermen for US$ 0.02-0.04/fingerling. The recommended selling weight is 300-400 g. Larger fish have many bones that are not market attractive. The selling price is US$ 2-5/kg of fresh, frozen, or smoked/sundried fish, depending on season.

Seaweed ready for harvest.

Milkfish Chanos chanos *cultured in Tanzania.*

A farmer holding sea cucumbers at his farm in Fukuchani village, Zanzibar, Tanzania.

Women seaweed farmers working in shallow coastal waters near Paje village, Zanzibar, Tanzania.

Shellfish

In the shellfish sector, species that are more valuable than those tried in the late 1990s and early 2000s are farmed. Rather than growing *Anadara*, farmers are now farming shellfish mainly for production of half pearls. Shellfish farming in Zanzibar started in 2004 and in 2005 half-pearl farming was initiated (Mmochi 2015). Species farmed are *Pinctada martensii, P. margaritifera, Pteria penguin,* and *Isognomon isognomon*. From experiments and subsequent farming on Unguja Island, shellfish for pearl production has expanded to Pemba Island and mainland Tanzania, especially southern Tanzania (Mtwara) and Mafia Island off the south coast of Dar es Salaam.

The bivalve *Anadara* is mainly used for conservation efforts in a community-based initiative known as no-take zones on the southwest coast of Zanzibar. In this initiative, juvenile bivalves are held in designated areas and grown to market size while comparing the take and no-take zones. A combination of methods in shallow and deep waters including fencing, nylon baskets, and floating rafts are used. Seed is mostly collected from the wild but sometimes it is purchased from fishermen. There are 11 farmer units engaged in shellfish farming (Fig. 2) and production was estimated at 13 kg (Fig. 3) valued at US$ 26 in 2012.

Data on pearl production is not available but it is estimated that about 1,000 pearls valued at US$ 10 to 20 each were produced in 2012 (Mmochi 2015) in Tanzania. The importance of pearl production in Zanzibar is increasing as shown by a recent study on spat collection (Ishengoma *et al*. 2011) aimed at setting a way for sustainable pearl farming industry. The potential of pearl oyster for bioremediation has been evaluated and pearl production could be a viable economic activity for coastal communities in East Africa (Southgate *et al*. 2006). However, the main challenge facing pearl production in Zanzibar has been market limitation. All studies show that future pearl production can be an economically viable activity, especially if the market problem is solved.

Sea Cucumber

Sea cucumbers have become increasingly important as an aquaculture product in Zanzibar, especially following overexploitation and a ban on collection from the wild (Mmbaga and Mgaya 2004). Sea cucumber farming started about five years ago and takes place in Unguja and Pemba, and mainland Tanzania (southern Tanzania, Mtwara and northern Tanzania in Tanga; see Fig. 1). The main species farmed are *Holothuria scabra*, *Actinopyga mauritiana*, and *A. miliaris*, usually farmed in fenced enclosures and cages. Like most animal aquaculture activities in Zanzibar, sea cucumber seed is collected from the wild directly by farmers or purchased from fishermen. There are 15 sea cucumber farmer units (Fig. 2), with 13 in Pemba and 2 in Unguja. Production in 2012 was 64 kg (Fig. 3), valued at US$ 400. Stocking to harvesting requires about 12 months. Sea cucumbers are usually sold fresh but sometimes are boiled and dried. Market prices range from US$ 1-12/piece, depending on the species and size. A number of institutions and researchers are promoting sea cucumber farming

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An alternative species (Gracilariopsis) *for seaweed farming growing naturally in Pemba, Tanzania.*

A seaweed farmer tying seed to culture lines.

in Zanzibar, converging with the high potential of farming sea cucumbers in Tanzania (Mmbaga and Mgaya 2004, Lovatelli 2004).

Crab Fattening

In Zanzibar and Tanzania in general, crab farming is done by fattening mangrove crablets collected from the wild. The species farmed is the mangrove crab *Scylla serrata*, using cages/pens and fenced enclosures. Seed is collected from the wild or purchased from fishermen for US$ 0.20-0.40/crablet of 100-150 g. The fattening cycle ranges from two weeks to three months, depending on the size of the crablet at stocking. There are eight farmer units engaged in crab fattening (Fig. 3) and the current production level is unknown. Crabs are sold fresh-live and the market price of crabs is US$ 1-17/piece, depending on the selling size and location. Higher prices can be obtained in Unguja because of high demand in tourist hotels.

Other Potential Species

In Zanzibar there are plans to farm other finfish species in cages rather than the currently used earthen ponds. Finfish species that have been identified for farming are cobia *Rachycentron canadum* and African pompano *Trachinotus* sp. The Ministry of Fisheries and Livestock is working with several partners to start marine finfish farming in cages.

Trials with sponge farming have been underway for more than two years in the southeast coast of Zanzibar (Jambiani) with promising results (Vaterlaus and Bumbak 2011). When disseminated to farmers, sponge farming can be another source of income for coastal Zanzibaris.

The IMS has been experimenting with two seaweed species in Makoba Bay between 1996 and 2005. The species are the agar-producing red seaweed *Gracilaria cornea* and the green *Ulva reticulata*, cultivated for biofiltration of fishpond effluent water (Msuya and Neori 2002, Msuya *et al*. 2006). Other *Gracilaria* species (*G. edulis* and *Gracilariopsis*) have been evaluated and their potential for agar production has been demonstrated (Buriyo and Kivaisi 2003). Recently there has been interest in other species such as the brown seaweed *Sargassum* and *Turbinaria* and the green seaweed *Caulerpa* triggered by demand from Chinese markets. Seaweeds have also been integrated with shellfish and sea cucumbers (Beltran-Gutierrez *et al*. 2014) as a sustainable production option.

Challenges

Challenges faced by farmers engaged in aquaculture in Zanzibar are:

- The price that farmers receive for seaweed is considered low and not fair compensation for the work done to produce the crop.
- Cultivated seaweed can become severely fouled by blue-green algae, wild seaweed, and other epiphytes. This happened in 2012 and has been a persistent problem in many seaweed farming areas, perhaps exacerbated by climate change impacts such as greater surface seawater temperature and input of land-based sources of nutrients (Msuya and Porter 2014, Hayashi *et al*. 2010).
- There is a lack of fingerlings for aquaculture. Collecting from the wild is not sustainable and thus hatcheries are important. The government of Zanzibar has partnered with the Korean International Cooperation Agency (KOICA) and the Food and Agriculture Organization (FAO) of the United Nations to start a milkfish/sea cucumber hatchery.
- Theft, mainly for animal aquaculture.
- There is a shortage of land and suitable sites for animal aquaculture.
- Heavy rains cause low salinity that leads to high mortality.
- Pond dikes may breach during extreme spring low tides. The tidal range in Zanzibar is more than 4 m and during extreme low tides the pond dikes could break even if they are properly made.
- There is a lack of markets or these are limited. This is a cross-cutting challenge for all forms of aquaculture.
- There is spare, inaccurate, or a lack of aquaculture data, mainly caused by a shortage of technical staff to do routine data recording.

Concluding Remarks

This article has shown that aquaculture, as indicated by the number of farmer units and production, is increasing in Zanzibar. Although seaweed farming has been practiced for close to three decades, animal aquaculture is now increasing quickly, despite its recent introduction. Pemba produces well above 75 percent of total animal aquaculture production and 91 percent of seaweed in Zanzibar. There are marked differences in the gender of seaweed farmers on the two Islands, with more women farmers in Unguja (93 percent) than Pemba (36 percent). There are challenges for all types of aquaculture and these must be addressed to pave the way for greater aquaculture production in Zanzibar.

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Notes

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