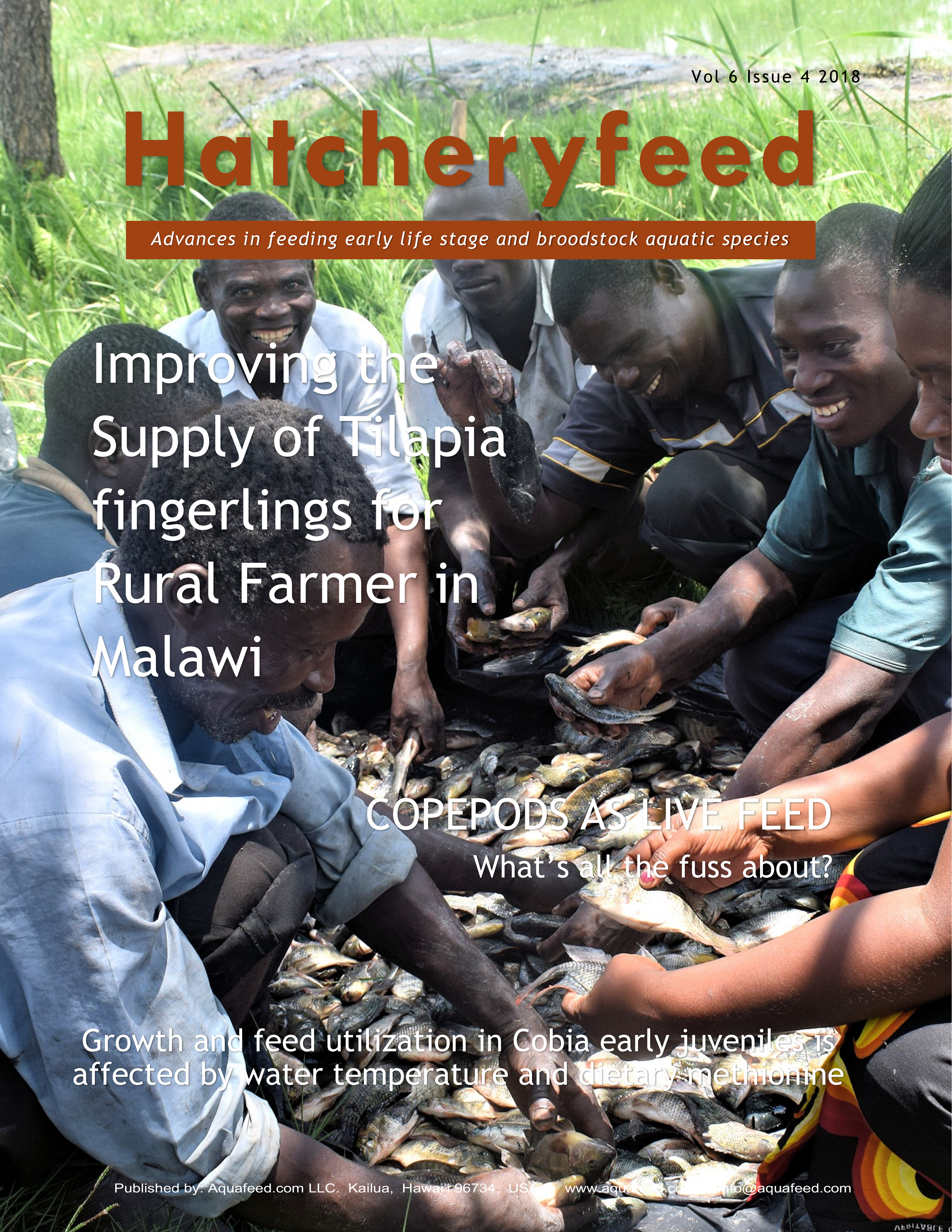

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Hatcheryfeed

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Improving the Supply of Tilapia fingerlings for Rural Farmer in Malawi

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Implementation of new hatchery technologies to improve the supply of tilapia fingerlings for rural farmer in Malawi

A contribution of the R&D project "Improving Community Health-Nutrition Linkages through Solar Energy Based Fish and Crop Integrated Value Chains (Acronym "ICH LIEBE FISCH"), a cooperation between Germany and Malawi.

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Background

The project is being accomplished under the umbrella of the German research cooperation for global food security and diversified agriculture for a balanced nutrition in Sub-Saharan Africa. The project is financially supported by the German Federal Ministry of Food and Agriculture (BMEL) through the Federal Office for Agriculture and Food (BLE). The project has mainly two German partners (Fraunhofer Research Institution for Marine Biotechnology and Cell Technology, EMB and the Association for Marine Aquaculture, GMA) and five Malawian partners and NGOs with the Lilongwe University of Agriculture & Natural Resources, Aquaculture and Fisheries Science Department (LUANAR-AQF) being the Malawian coordinator in the project.

Introduction

Research or development conducted during developmental aid projects in rural areas of Sub-Saharan Africa, especially in smaller communities, can only be of benefit for a very limited time Mostly, projects are focused on one or few specific aspects, such as improving water quality, providing novel gear or implementing new technologies. These, on their own, do not take into account the value chain, which is important for the development of a sustainable local economy. A project considering the value chain of sustainable integrated agriculture (crops and plants) and aquaculture of endemic freshwater finfish production in rural areas would have the potential to overcome this bottleneck in sustainability. Thus, the project "Ich liebe Fisch" (I love fish) focuses on research and linking of several aspects along the value chain of sustainable aquaculture of endemic tilapia species, a favored and high-quality source of protein for human nutrition. In this context, an innovative linkage of fish and crop production in integrated aquatic systems (traditional integrated agriculture-aquaculture systems, IAA, and aquaponics) will allow enhanced productivity and thus an optimized nutritional and socio-economic status of smallholder farmers in rural areas of Malawi adopting these techniques.

Malawi is a landlocked country in south-eastern Africa, bordered by Zambia to the northwest, Tanzania to the northeast and Mozambique to the south, southwest and southeast. Malawi is among the world's least-developed countries. The economy is heavily based in agriculture, with around 85% of the population living in rural areas. Over 80% of the population is engaged in subsistence farming.

The project aims to improve the supply of tilapia as food fish specifically in rural communities and to advance crop production by introducing small-scale aquaponic facilities and enhancing pond-based integrated aquaculture-agriculture (IAA) approaches. The project has a quite diverse agenda; briefly, the specific goals of this project are:

- to enhance the production of endemic fish species by selective breeding and hybridization
- to establish a specialized solar powered hatchery and to optimize rearing protocols of the most desired tilapia species in Malawi, specifically the Chambo (*Oreochromis karongae*), in order to improve the sustainable supply of fingerlings of this species for on-growing farms,
- to use an IAA system approach to integrate nutrient fluxes between animal and crop production,
- to implement training courses for local communities and smallholder farmers, thus ensuring capacity development and
- to monitor the changes in health status and food habits of local families - especially children and elderly people—after implementation of the project measures, to ensure a benefit for the whole community and
- to facilitate establishment of a community agriculture-nutrition-health linkage innovation platform and networking with relevant institutions to ensure sustainability beyond the project´s life cycle.

This article focuses mainly on the aspect of the implementation of innovative hatchery technologies that aim to shift the production of tilapia fingerlings in Malawi to the next level.

In combination with the introduction of aquaponics and efficient application of integrated agricul-

Children are the special focus of the project "Ich liebe Fisch", which aims to improve the nutritional condition of Malawian folk in rural areas. These children are just undertaking a "taste test" of porridge with fish.

ture-aquaculture (IAA) the goal to have more fish and vegetables available as a healthy enrichment of the popular maize dishes can become a reality.

Rationale

Traditionally, Malawi is a fish-eating nation. However, what is left on the table is mainly maize mush, traditionally called Nsima.

Daily dish in the countryside: Nsima, the traditional maize mush, enriched with some small freshwater sardines from Lake Malawi.

Although Malawi is blessed with the ninth largest lake in the world and the third largest and second deepest lake in Africa, overfishing has resulted in the collapse of the tilapia fishery in the lake since the beginning of the '90s. Tilapia-like species, specifically *Oreochromis karongae*, known locally as chambo, is the country's favorite fish. Owing to the Chambo scarcity on the market, its wholesale price has risen from 2.5 Malawian kwacha per kilo in the early 1990s to 130 Malawian kwacha per kilo in 2002. Today, the price has reached more than 3000 – 6000 Malawian kwacha (approximately US$ 4-8) per kilo which is hardly affordable for most Malawian people. The historical yields of 70% of Chambo (*Oreochromis karongae*) in the nets has turned into only 3–5% Chambo today, with small fish called Usipa (Lake Malawi sardine, *Engraulicypris sardella*) being the most prominent fish in the catches from Lake Malawi, at present providing 70% of the yield.

Under these circumstances, aquaculture is being considered as one of the measures to provide more Chambo on the table and for the market, however, the production in the country is still small and in general not efficient. Aquaculture has a tradition of about 100 years in Malawi, introduced while England was ruling Malawi, taking off with about 60 ponds in the 1950s and is represented today by about 6,000 active fish farmers. At present, about 3,600 tonnes of tilapia-like species are being produced annually by the rural farmer. One of the major bottlenecks for smallholder farmers to improve their yield is the scarcity and unreliable of sufficient viable fingerlings, specifically from Chambo.

Propagation and production of fingerlings is usually conducted in ponds with all generations of tilapia. This implies, however, an unfavorable environment for fingerling production, including predation (predatory tadpoles from frogs are a huge problem in open ponds), cannibalism, feed competition and environmental impact. Thus, the number of offspring that can be expected from the farmer in a breeding season is unknown.

Innovative hatchery technology for Malawi

Thus, one of the major goals of the project ¨Ich liebe Fisch "was to establish technologies which improve significantly the stable supply of viable fingerlings to farmers who want to grow fish for food and for the market. To achieve this goal, the project has provided a solar powered indoor hatchery which is designed to support intensive production of tilapia fingerlings, specifically from Chambo.

The hatchery is based on a design which has proven its usefulness in fish larval rearing for more than 25 years. The design was adapted to the specific needs under the conditions in Malawi and the kind of species which will be reared in this facility. The main elements of the hatchery are two large fiberglass tanks with smaller tanks hanging inside of the big tanks (Figure 1). The advantage of this compact design is obvious. The water conditioning can be

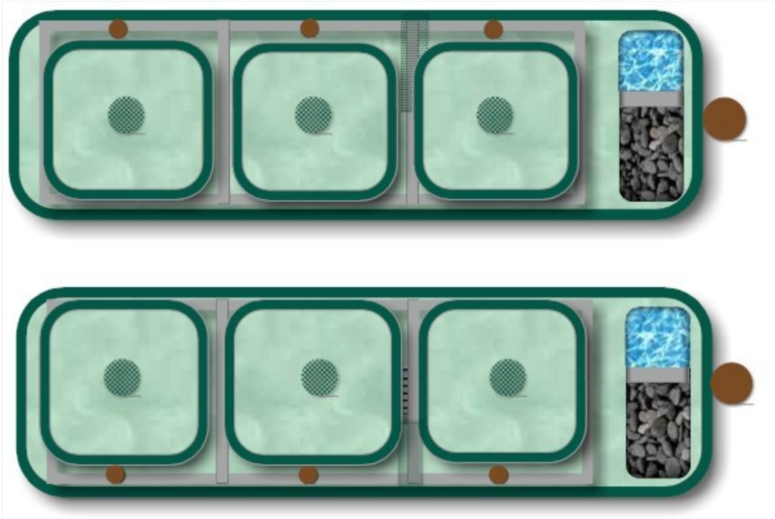


Fig.1. The hatcheries main elements are two identical units; each unit has a large fiberglass tank with three smaller tanks inside. Dimensions of the large tanks about 6.0 x 1.9 x 1.1 m (L x W x H). Dimensions of the smaller tanks are about 1.3 x 1.2 x 0.7 mm. Each unit has the same equipment and can be operated independently from each other, which allows, for example, rearing trials with different water temperatures.

accomplished in the big tank (heating, aeration, filtering etc.) without having any mechanical impact on the larvae inside the small tanks. On the other hand, the larvae inside of the small tanks are practically swimming in about 12 m^3 of water. The water in the big tank keeps the water temperature constant for all smaller tanks, which is a huge advantage if research trials are conducted in this facility.

The equipment used and the water flow is depicted and annotated in Figure 2. Each unit has a two-way circulation and can be operated in a batch mode, which means that a certain volume of water, based on the current water condition, is

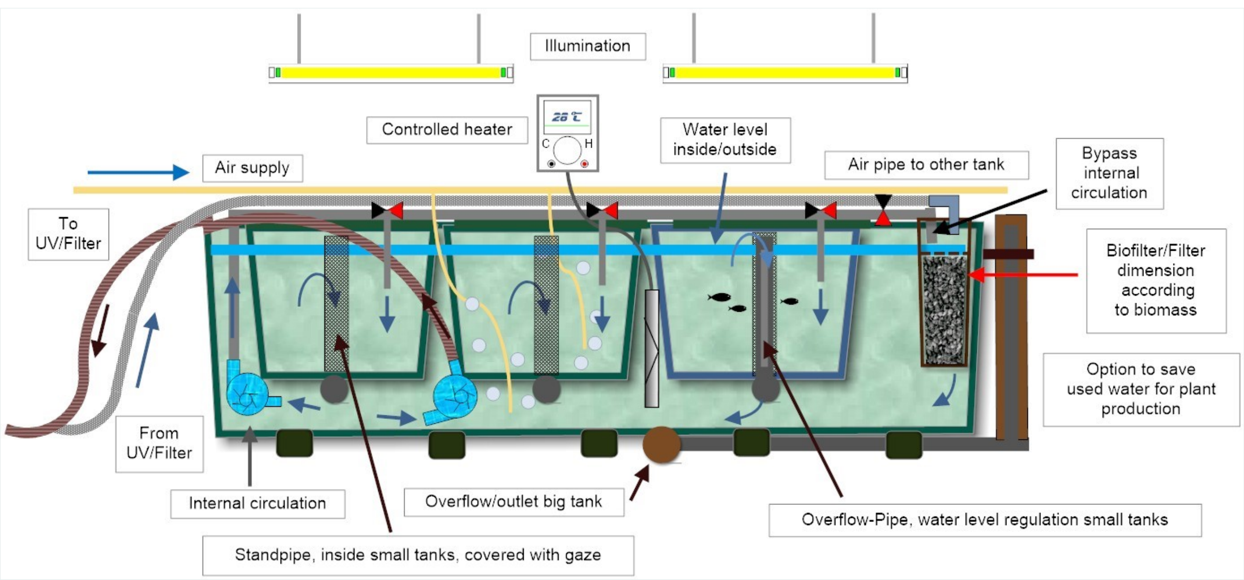
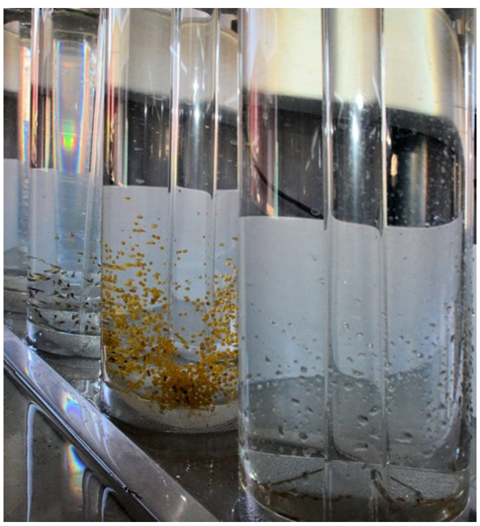


Fig. 2. The sketch depicts schematically the water circulation and the equipment installed in one tank unit. Water from the big tank is pumped through a UV-unit, a filter unit outside which can be equipped with various filter cartouches and goes back to a coarse filter inside of the big tank. Attached to the coarse filter, a biofilter is established which is fed with returning bypass water from the big tank. The other pump circulates the water from the big tank through the small tanks. Heaters are de-ployed in the water body of the big tanks. Significant aeration is accomplished in the big tanks, inside the small tanks only gentle aeration is applied to keep larvae in the water column. Ball valves at each water inlet into the smaller tanks allow the adjustment of the water current and, depending on the age, to adjust a more or less gentle current, drifting around the larvae so they cannot get stuck in the corners. The tanks can be operated in a batch mode, i.e. a certain water volume can be exchanged on a daily basis if necessary, or the tanks can be operated in a flow-through mode.

The hatchery in operational mode



Incubation unit: McDonald-type hatching jars, stocked with some Chambo eggs.

Tilapia (Chambo) fingerlings.

being exchanged or the system can be operated in a flow-through mode. The second option might be difficult to apply under the conditions in Malawi, since constant water pumping often fails because of frequent failure in grid electricity.

The prototype of the hatchery was set up in March and April 2018 at the farm of the Bunda College in Lilongwe which is part of the Lilongwe University of Agriculture & Natural Resources, Department of Aquaculture and Fisheries (LUANAR) and was ready to operate in the next breeding season, which starts in November and lasts normally until April.

In addition to the main rearing tanks, an egg incubation unit was established inside next to the tanks, based on McDonald-type hatching jars. Since the target species in the project are mainly mouth breeders, the eggs can easily be retrieved from the females. This facility along with the rearing tanks completes the full control over the entire hatching and rearing process, facilitating also the effort of selective breeding, in order to improve the performance of the larvae and to control the results of hybridization experiments (one attempt in the project to produce all-male generations).

Solar power supply

Grid power in Malawi fails frequently, at present in the mean only six hours of power from the public grid per day can be expected. Since such a hatchery set -up needs constant power supply in order to run pumps, aeration, illumination and heaters without a break, a solar power unit was attached to the hatchery. Gensets as a continuous provider of power is not an option, since fuel and gasoline are very expensive in Malawi. The solar power unit was designed as an island solution and provides sufficient power for the equipment in the hatchery 24h/7days a week. The solar facility provides about 1.7kW in the night which is sufficient to run the most important equipment without a break. The solar power can automatically switch to grid power when available (Figure 3). A diesel genset which automatically starts is

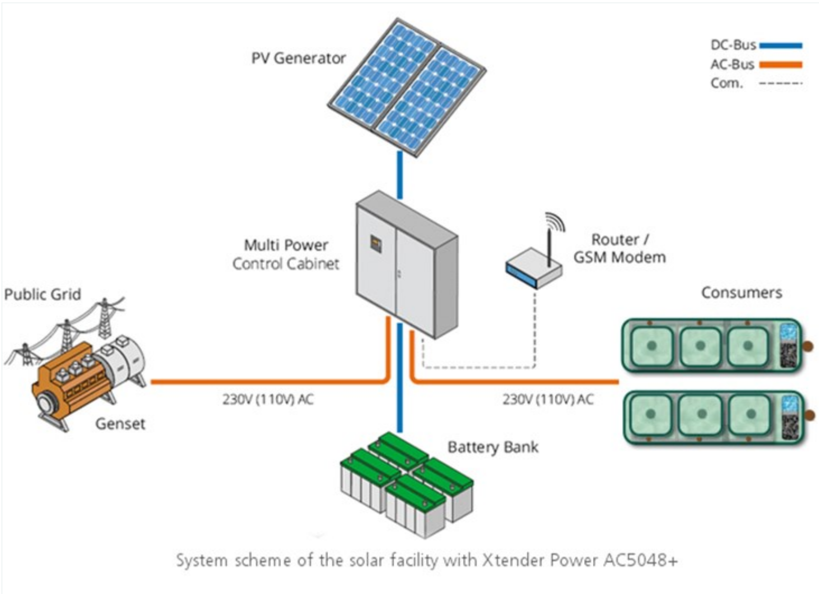


Fig. 3. Schematic sketch of the solar power facility which provides permanent electricity for the hatchery operation. The system has 36 solar panels, each providing about 300 Watt. The battery block has 24 batteries with in total 48 Volt and 1270 Ah per battery. The facility is designed as an island solution; however, grid power can be used when available to increase the batteries' life time. Additionally, a genset is attached as emergency back-up. The system can be remote-controlled through a GPRS modem.

Mounting the 36 solar panels that are the heart of the solar power facility that provides electricity for the hatchery.

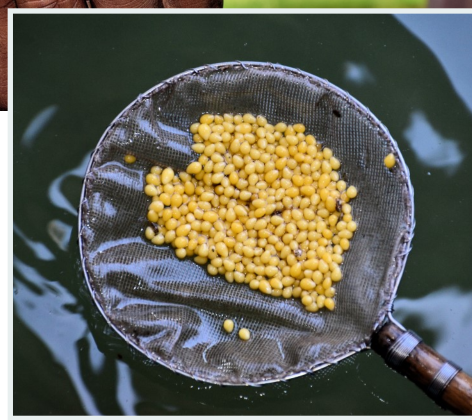
being installed as an emergency back-up when both other sources for electricity fail.

A GPRS modem was connected to the control unit, which allows the remote control of the operating data of the facility through the Internet, which is very useful in the period beyond the first start-up of the system.

Production and research

The hatchery was mainly designed to produce tilapia fingerlings to support stocking of the ponds of the rural farmers. However, the facility can also be used to do research trials; this is important since a number of optimal biotic and abiotic conditions for e.g. the Chambo are not yet known but can be identified in experiments conducted in the hatchery. In order to increase the number of parameters to test and to be able to achieve viable results with more replicates, small floating buckets can be introduced into the tanks with larvae introduced into the buckets.

The capacity per rearing trial is about 50.000 tilapia larvae per unit. One trial in the indoor hatchery takes about 4 weeks, subsequently the post larvae are introduced into hapas in the ponds of the farm where they are able to adapt to pond conditions in a protected environment, and are raised until they have reached the right size to be disseminated to the farmer (about 5-10 g). In a breeding season, about 5 trials can be conducted, which can provide about 0.5 million fry per breeding season, assuming, there are sufficient brooders available. This capacity is good for stocking the



Above: Endemic Tilapia species *Oreochromis karongae*, the Chambo.
Right: Eggs from Chambo, taken from the female and ready to incubate in the hatchery.

ponds of 5-10 fish farming communities, depending on the number and size of the ponds they are managing.

Conclusions and outlook

To some extent, it might appear to be very ambitious to establish this hatchery level 2.0 in one of the poorest countries on the globe. However, it has to be taken into account that the location where the solar powered hatchery was established is at the farm of the Bunda College, which is part of LUANAR, and which was approved by the World Bank in 2016 as a Centre of Excellence in Aquaculture and Fisheries Sciences in Africa.

Thus, with the excellent infrastruc-

A fish club harvests a pond. A fish club can be a couple of people working together, or even a whole village who operate and manages farmland and ponds together.

to facilitate the production of high-quality fish feed inside Malawi, the project aims to establish a pilot plant to demonstrate the production of maggots of the black soldier fly under local conditions and eventually meal from insect proteins which can be used to produce a protein rich feed which will help to utilize the growth potential of the fish in the farmers ponds.

ture at the Bunda Farm with its many ponds and safe water supply, it was considered a proper environment to shift the production of tilapia fingerlings to the next level in Malawi. Since the hatchery is being operated by the excellent and knowledgeable staff of LUANAR, who were thoroughly trained by the German partner, there are no doubts that this facility will be able to contribute significantly to improve the tilapia production of the rural fish farmer on the long-term scale in Malawi.

Feed is still a major bottleneck

There is, however, one major bottleneck for the rural fish farmer in Malawi. Even with the supply of sufficient viable fingerlings, the on-growing conditions are still very weak, concerning the feed available to the farmer. Malawi has no production of commercial fish feed, and rural farmer cannot afford to import pelleted fish feed from e.g. Zambia. Thus, the farmers are using homemade feed, which is mainly remnants from maize processing (maize bran) and which has very little value as fish feed and does not come close to making use of the growth potential of the tilapia species. This situation can actually jeopardize the effort to improve the yields which can be achieved with the availability of significantly more fingerlings. Thus,

Malawi has no production of commercial fish feed, and rural farmer cannot afford to import pelleted fish feed … thus farmers are using homemade feed.

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More information

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