Bundesministerium
für Ernährung
und Landwirtschaft

Forschungskooperationen zur Welternährung

Research cooperation for global food security and diversified agriculture for a balanced nutrition in Sub-Saharan Africa.

Akronym "Ich liebe Fisch"

Project title Improving Community Health-Nutrition Linkages through Solar Energy Based Fish and Crop Integrated Value Chains.

country/countries	Malawi
funding agency	Federal Ministry of Food and Agriculture - BMEL
project management	Federal Office for Agriculture and Food – BLE
project coordinator	Fraunhofer Research and Development Center for Marine and Cellular Biotechnology (EMB)
project partner(s)	2. Association for Marine Aquaculture mbH (GMA) 3. Lilongwe University of Agriculture & Natural Resources, Aquaculture and Fisheries Science Department (LUANAR-AQF) 4. Lilongwe University of Agriculture & Natural Resources, Department of Human Nutrition and Health (LUANAR-HNH) 5. Lilongwe University of Agriculture & Natural Resources, Department of Food Science and Technology (LUANAR-FST) 6. Quantum for Urban Agriculture and Environmental Sanitation (QUALIVES) 7. Innovative Fish Farmers Network Trust (IFFNT)Innovative Fish Farmers Network Trust (IFFNT)

project budget	1.708.071,20 €
project duration	1. März 2016 – 31. Mai 2021
key words	Aquaculture, aquaponics, solar powered hatchery, fish breeding programs, hybridisation, fish, gamets, cry preservation, population genetics, fish larvae, fish seedlings, tilapia, chambo, "all-male" populations, fish feed, black soldier fly BSF, insect proteins, integrated aqua-agriculture (IAA), vegetable production, health status, social status, malnutrition, food diversity, capacity building, training, cooking classes, networks, food processing
background	Traditionally, Malawi is a nation where a lot of fish is consumed. However, the main food is now mainly maize porridge. The overfishing of Lake Malawi since the beginning of the 1990s has made fish in general, but especially the tilapia species O. karongae, or "chambo" in the local language, almost unaffordable for most people in Malawi. Against this background, the primary aim of the project "I love fish" was to improve the supply of fish and vegetables to the rural population and to increase the added value. This was intended to improve food security and the health status of the participating village communities as well as to increase their earning potential. Capacity building should also be supported, i.e. the increase in knowledge ensures the sustainability of the measures on the one hand, but also creates multipliers from whom the village communities not involved in the project can learn. The project has also addressed another significant problem area, which is the lack of food quality for juvenile and adult fish. One option is the production of black sol-dier fly (BSF) larvae, which can be used to produce very low-cost animal protein in Malawi. This approach was successfully pursued in the last project year until the beginning of 2021.
objective	In detail, the focus was on the following project activities: i. Measures to improve the production of indigenous tilapia species through more efficient rearing conditions and the production of "all male" fingerlings. ii. Construction of a larval rearing facility powered by solar energy to improve the supply of fingerlings, especially *O. karongae* (Chambo). iii. Application of integrated aqua-agriculture (IAA) to use the excrements produced by fish in the ponds as nutrients for plant cultivation via irrigation water. iv. Introduction and dissemination of aquaponics technology in Malawi (integrated fish and vegetable farming in circulating systems) v. Extraction of high quality proteins from the rearing of BSF larvae from organic residues for the production of high quality but low cost fish food

	vi. Conduct training courses to communicate expert knowledge and to facilitate capacity building in the rural communities. vii. Survey the health status and dietary habits of rural families, especially those of children and the elderly, before and after the implementation of the project interventions viii. Support the establishment of a network and a knowledge platform to promote exchange between the different communities and thus ensure the sustainability of the project measures even beyond the end of the implementation of the project.
results	The most important project results: i. The establishment and commissioning of the first solar power assisted hatchery in Malawi for intensive rearing of fish fingerlings for rural fish farmers has been successfully completed. The hatchery has already produced seedlings in the second hatching season close to the initial estimated production capacity (0.75 mill.) and could be operated continuously without disruptions except for a technical failure of the inverter (warranty repair). By optimising the processes and stocking up the hatchery fish, the seedling production could be increased by about 620% by the end of the project compared to the initial situation. The hatchery now also supports the culture of tilapia hybrids, and focuses on the production of "all male" cohorts as they utilise feed more efficiently and grow faster. ii. Some of the farmers who participated in the training course on the operation of the hatchery are now building small hatcheries themselves, based on the model of the one built by the project, and want to produce fingerlings as an additional source of income and sell them in the local area. iii. The training courses on optimised pond management and the support with materials and feed has led to a 4-7 fold increase in fish production efficiency per season, depending on the region. The implementation of the results on breeding selection have contributed to the increase in fish production. iv. The implementation of Integrated Aquaculture-Agriculture (IAA) training courses, when applied consistently, has led to a significant improvement in vegetable production among rural aquaculture farmers. The village communities participating in the project were found to have a significantly higher standard of living when the end-of-project survey data was analysed, compared to the entry survey data. v. Two aquaponics systems were constructed and commissioned at Bunda College farm and Benga Parish (mission community) in Nkhotakota district. In addition to the simple barrelponics system (aquaponics system made of plastic barrels) that was built and tested as part of the project, the two large systems now produce vegetables and fish in routine operation. The systems are also used for training purposes. In regular training courses, interested farmers were trained in this technology, which is new in Malawi. In Malawi, the

	aquaponic technique is particularly suitable for vegetable farming even in the dry season. The water requirement is only about 5% compared to traditional vegetable cultivation in fields vi. Expanded clay balls are the optimal substrate for the plant beds in an aquaponic system. Since this type of substrate is not available in Malawi or would have to be imported, the project initiated an expanded clay ball production. Using the production techniques developed at Benga Parish by the project, expanded clay balls are now produced by a small cooperative in Nkhotakota District and sold at a fraction of the import price. vii. Farmers in the rural communities are not able to buy imported full quality feed (industrial pellet feed) for fish rearing and therefore essentially use waste from maize processing to feed fish with only low protein content. The project therefore also looked at developing alternatives and sources of protein available in Malawi for fish feeding in order to be able to produce wholesome but also affordable fish feed for rural aquaculture farmers. The focus was on the production of larvae of the black soldier fly (BSF, *Hermetia illucens*). The larvae of the BSF can be reared with organic residues, which are also available in Malawi in sufficient quantities and practically free of charge. The flies are easy to breed, undemanding, omnivorous and also widespread in Africa. The larvae have a high protein content and the profile of the amino acids in the pupae is very similar to that of fish meal. The "I love fish" project has commissioned a pilot plant at LUANAR's Bunda College for the production of black soldier fly, which is mainly used as a training facility for rural aquaculture farmers in Malawi. viii. Several training courses were held on whole food nutrition and making new products from fish, especially for children and youth. In addition to women, men from the community councils also participated, as well as school children. Practical exercises were used to show which different foods can be made from fish, maize and cassava in order to improve the acceptance of fish and thus the nutritional conditions, especially among young children. Through these measures, a considerable increase in dietary diversity was achieved among the participating village communities. ix. With the support of the "I love fish" project, one doctoral thesis, 5 master's theses and 8 bachelor's theses were completed. x. In addition to the village communities originally selected in the project, other farmers were involved in the trainings, although to a lesser extent, and new networks were established between the village communities and individual farmers. xi. After completing their training, the master students trained in the project now use the knowledge and skills acquired in the project in the context of current projects of other organisations (e.g. GIZ, WorldFish). One former Master's student has now founded a start-up and advises and builds aquaponic systems.

	xii. The Lilongwe University of Agriculture and Natural Resources (LUANAR) is the first public university in Malawi whose degree programmes have been internationally accredited. The facilities implemented by the project at Bunda College were an important foundation for the successful accreditation.
recommendations	Recommendations arising during the project implementation i. The cooperation with Benga Parish (Missionary Community of Saint Paul the Apostle from the Diocese of Lodwar) has proved to be extremely helpful and fruitful in the course of the project; in future projects, even greater emphasis should be placed on network building involving institutions such as NGOs, development aid organisations or governmental organisations of the respective countries. ii. From the exchange of views with the farmers at the end of the project, the recommendation was to involve the participating communities at an earlier stage, during project planning. The participating communities should already be involved in the compilation of the project application and thus be motivated to increasingly support the implementation of the measures. iii. A fundamental problem in sub-Saharan Africa that goes beyond the achievable goals of this project is the loss of food through rotting. The FAO estimates that about 37% of food is lost to consumption due to poor preservation methods. Since the rural population in Malawi does not have refrigerators or freezing facilities, there are almost no possibilities to preserve food for a longer period of time. Due to the strong seasonality, fruits and vegetables in particular are only available for a short period of time. Another important step towards a secure basic supply of healthy food is therefore the implementation of preservation methods in Malawi. This would have various positive aspects, such as the production of jams and sun-dried fruits, which could not only be produced for own consumption but also sold. Fresh fish, which is only available for a short time after fishing, could also be preserved for a longer period. In addition, the daily time needed to procure fresh food could be reduced. Especially against the background of the expected negative consequences of the Corona pandemic for developing countries such as Malawi, such measures are also very helpful and urgently needed, which support the stockpiling of food through preservation options.

	iv.	In the context of improved usability of food (as described in paragraph iii), integration of all production stages for fish and vegetables, including further processing stages, can significantly increase the efficiency of food production. It would therefore be desirable to support the widespread application of aquaponics technology in Malawi and link it to the farming of BSF. In this way, material flows can be circulated, fertiliser can be saved and food losses can be reduced. For example, the fish, fruit and vegetable waste from the village communities can be used to feed the insect larvae, which in turn can be fed to the fish. This supports a sustainable biomass cycle. The aquaponic technique is also particularly well suited in Malawi for vegetable farming even in the dry season. The water requirement is only about 5% compared to traditional vegetable cultivation in fields. Since aquaponic systems are modular in design, expansion stages can be connected at any time. The necessary power generation for some pumps can be realised with relatively small and inexpensive solar power systems.
	v.	In connection with paragraph iii, analyses in the common dishes for sufficient supply of essential micronutrients such as vitamins and minerals are recommended, as well as measures to be able to close the resulting supply gaps.

The following picture collages are a selection and are intended to give a visual impression of the activities carried out in the project. Almost all of the pictures shown here are available in high resolution and can be shared if desired. Many more pictures are also shown on the project's website (www.fish-for-life.org). Please send enquiries to B. Ueberschär, ueberschaer@gma-buesum.de

Fotos



From left to right: Lectures in the training course on operating the hatchery fish plant in the morning. "Hands on" training. Participants determine the water quality in the Hatchery (ammonium, nitrite, nitrate, pH). Measurement of oxygen and temperature.



From left to right: Seedlings for the farmers' ponds from Bunda Farm. Transporting the seedlings to the farmers' ponds. Temperature adjustment of the transport bags before release.



From left to right: The aquaponic system on the Bunda College farm. View over the plant beds shortly after construction (still without substrate). Training course in aquaponics, here demonstration of the barrelponics variant.



From left to right: Group picture with the farmers who took part in the excursion to Mr. Mysali's farm. Mr. Mysali talks about his experiences with fish farming and IAA. Besides fish, vegetables and fruits are also produced on the farm and fertilised with pond water.

Fotos












Above, from left to right: Adjusting the tanks for the pump sump of the aquaponic system. As above, left. Clay ball production with village members at the Benga Perish site. 2nd row from top, from left to right: Installation of the plant beds. Optimised kiln for the clay balls. Aquaponic system with plant beds made of expanded clay balls produced at Benga Perish. 3rd row from top, from left to right: Volunteer T. Knörr with Benga Parish staff. Volunteer from the abacus e.V. association in Rostock training Benga Parish staff. Finished aquaponics system in Benga Parish. 4th row from top, from left to right: Checking the plant growth in the aquaponic system. Aquaponics training course at the Benga Parish facility. Healthy vegetable plants in the plant bed of clay balls (Mustard leaves, Mpriru, grown for the first time under aquaponic conditions).

Fotos



From left to right: Final meeting on the first phase of the "I love fish" project at the end of September 2019, with a symbolic handshake to hand over the hardware between Ariana Bystry (Project Administration, BLE) and Dr Agnes Mwangwera (Bunda Campus Director). Discussions between villagers and Ariana Bystry and with a district fisheries officer (right, Dr Rakers, A. Bystry



From left to right: Fish harvest in a partner community in Mchinji District (Chikondi Fish Club). The fish are measured by sampling and the measurements are immediately digitised for further analysis. Typical size of the harvested fish at this community after a 5-6 month grow-out period (about 120-170g). The picture shows an O. shiranus.



From left to right: Fish harvest in a partner community in Mchinji District (Chikondi Fish Club). A boy is happy about a fish he caught while fishing in the drainage ditch. The treasurer of the fish club counts his income from the fish sale. Fresh fish for the villagers.

Fotos



From left to right: Insectarium with the "love cages" for reproducing the BSF. In the middle, the larvarium in which the boxes with the substrate and the larvae are housed. Larvarium and insectarium have to be separated, as the demands on the environmental conditions for the different life stages are very different. The BSF is widespread in the wild in Malawi, so that it is unproblematic to initially build up a brood stock via wild catches.



From left to right: Participants in the BSF workshop with some of the supervisors. A solar dryer built by the project is very efficient to dry the BSF larvae. This step is necessary if the larvae are to be further processed. The participants of the workshop test the solar dryer with some BSF larvae.



From left to right: As a solar dryer is also suitable for drying fruit and vegetables to achieve shelf life, this application was also demonstrated in the workshop, here with banana slices and mangoes. In the BSF workshop, the participants had the opportunity to build a "Biopod", a starter kit for BSF cultivation. Participants were able to take the "biopod" with them and use it to gain initial experience of BSF breeding in their communities. Among other things, the participants learned to identify the stages of BSF larvae. This is important because certain stages are optimal to be mixed into the fish feed.