

The role of fish in food and nutrition security in developing countries: focus on combating micronutrient deficiencies

Application to the Council for Development Research (RUF), Ministry of Foreign Affairs, Denmark, for a research and research capacity building project with the following components:

1. Research and research capacity building at the Faculty of Fisheries, Bangladesh Agricultural University (BAU), Mymensingh, Bangladesh
2. Research and research capacity building at the Inland Fisheries Research and Development Institute (IFReDI), Department of Fisheries (DoF), Phnom Penh, Cambodia
3. Research at the Department of Human Nutrition (IHE), The Royal Veterinary and Agricultural University (KVL), Denmark and other Danish research institutions

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2. DESCRIPTION OF THE PROJECT

2.1 BACKGROUND

"The hidden hunger"

Too many people live in poverty and suffer preventable deaths in developing countries. Poverty and malnutrition go hand in hand and malnutrition is responsible for much suffering in poor people (Haddad, 2002). Over the past decades, micronutrient deficiencies have been documented to be among the major underlying causes of high morbidity and mortality rates in developing countries (Black, 2003). Micronutrient deficiencies are caused by poor nutritional quality of the diet. The diets of poor people in developing countries are dominated by a single staple food, such as rice in Asia and maize or cassava in Africa. Staple foods lack sufficient amounts of most vitamins and minerals to meet human needs. With the staple food, small amounts of vegetables and even smaller amounts of animal foods are eaten. These foods must supply a range of vitamins and minerals in sufficient amounts - or micronutrient deficiencies occur. Micronutrient deficiencies are collectively termed "the hidden hunger". The victims do not appear visibly hungry, but the foods they ate do not fulfil their nutrient requirements.

The Millennium Development Goals (MDGs) agreed upon by the United Nations members in 2000 aim at reducing the number of people living in extreme poverty and the mortality rates of children and women (ACC/SCN, 2004). Combatting micronutrient deficiencies is a step towards reaching the MDGs. Improved nutrition is an investment in human capital to stimulate economic development (Haddad, 2002; Demment et al., 2003). Vitamin A deficiency alone affects as many as 250 million children and causes retarded growth, blindness and early death. Iron deficiency is recognised as the most widespread nutritional disorder globally, estimated to affect at least 2 billion people. Children and women are the most vulnerable groups. The human costs are high, causing retarded cognitive development and maternal death. The economical consequences are also high. It has been estimated that iron deficiency alone costs a reduction of the gross national product in Bangladesh of 7.9 % due to lost working capacity and impaired learning capacity in school children (Horton & Ross, 2003).

Fish as food in developing countries

In developing countries with access to water, fish is "the poor man's animal food" (Kent, 1997). Poor people have access to and can afford small amounts of low market value fish, while other animal foods - meat, egg and milk - are too expensive and therefore are rarely eaten. Low value fish are generally small fish species, while large fish fetch high prices. This is the case in the partner countries: Bangladesh, and Cambodia selected in this project. In Bangladesh and Cambodia, the fish consumption reflects the high biodiversity of the floodplains, rice fields, ditches, rivers and lakes. Hundreds of small, cheap fish species are commonly consumed by the poor. In Bangladesh, pond culture of carp species has been successfully introduced and compensates to a certain degree for a declining fisheries in floodplains and rivers. These carp species have low contents of micronutrients. The nutritional consequence of replacing small, nutrient dense fish with carps in the Bangladeshi diet has not been considered.

The role of fish in human nutrition

The nutritional benefit of animal foods, especially as a source of animal protein is well recognised (Murphy & Allen, 2003). However, recent research has shown unexpectedly high benefits of quite small amounts of animal foods in children's diets. A study in rural Kenya showed that among malnourished children, a small supplement of meat improved cognitive and physical development and physical activity (Whaley et al., 2003). In our previous research, we have documented that fish is an overlooked source of important micronutrients (Thilsted & Roos, 1999). Small, commonly consumed fish species in Bangladesh have been shown to be an important source of vitamin A and

minerals in poor, rural households (Roos et al., 2003b; Larsen et al., 2000; Roos et al., 2002).

The role of fisheries and aquaculture in poor communities

In developing countries with a rich aquatic environment, employment in fisheries (and also aquaculture, if developed) marketing and processing of fish, as well as income generated from taxes and fishing licenses are important for the socio-economy of communities which depend on fish. Households in fishing communities generally belong to the poor sector of the population (Béné, 2003). Special emphasis must be placed to balance the interests of these households with the needs for cheap and nutritious fish. This is a challenge to be met when developing strategies to increase fish production.

The role of fish in food and nutrition security

Food and nutrition security are important parameters in the overall livelihood security of poor households (Frankenberger & McCaston, 1998). The combined facts that:

1. fish is the most commonly consumed animal food in diets in poor populations in developing countries with access to water;
2. animal foods contribute micronutrients which are essential for the cognitive and physical development in humans; and
3. fish production (fisheries and aquaculture) are economically important for dependent communities

place fish in a central role in food and nutrition security in developing countries with access to water.

2.2 PARTICIPATING INSTITUTIONS

The partner institutions: contributions and gains from the proposed project

The IHE, KVL has long-term experience in research in human nutrition in developing countries. The partner institutions in Bangladesh and Cambodia are selected for their combined strengths in research related to inland fisheries and freshwater aquaculture, mainly in the fields of biology and socio-economy. The purposes of working with these three institutions are to strengthen research in order to enhance the nutritional contribution from fish in poor populations in the partner countries, and to enhance and strengthen the research capacity in the partner institutions in the field of food and nutrition security.

The project partners met at a preparatory workshop held at the IFRaDI, Phnom Penh, Cambodia, on 9th - 10th September 2003. The workshop was funded by the RUF.

Denmark

At IHE, Section for nutrition in developing countries, KVL, our research focuses on the nutritional value of commonly consumed foods in developing countries. Commonly consumed fish - especially small indigenous fish species have been the subject in a number of research projects since 1992. A list of the completed and on-going projects as well as the contribution from each project to the understanding of the role of fish in food and nutrition security are shown in Appendix 5. The small Bangladeshi fish species, mola (*Amblypharygodon mola*) has been used as the "model species" for many

of our research projects. Mola has been identified as having an exceptionally high content of vitamin A and at the same time it is a well-liked and commonly consumed fish. Complementary to field research in developing countries, basic research questions on to the nutritional value of fish have been studied in the laboratories at IHE and collaborating Danish research institutions. The results from these complementary research activities are important to fully understand the role of fish as a dietary source of micronutrients. Our contribution to the project is 1) to coordinate project and network activities, 2) to support the partner institutions in all aspects of human nutrition and 3) to conduct advanced research in the content and bioavailability of micronutrients in fish. We thereby assist our partner institutions in integrating nutrition objectives in the development of fish production policies and strategies. This has been successfully initiated in Bangladesh through our previous projects. Our gain from the proposed project is to enhance our capacity to integrate food production and human nutrition in an interdisciplinary approach.

Bangladesh

The Faculty of Fisheries, BAU is an "old" partner institution in the "Food and nutrition security ENRECA project", as well as other research projects. BAU is the only agricultural university in Bangladesh. The contribution from BAU to the proposed project is to make available the knowledge and experience of integrating aspects of food and nutrition security in fisheries research agenda. Fish consumption and the nutritional value of commonly consumed fish have been studied in previous projects and development of strategies to enhance the production of nutrient dense fish species has taken place. This experience can be transferred to Cambodia and Kenya with regard to the selection of methods, development of research protocols and interpretation of data. BAU has developed an economically sustainable strategy to produce vitamin A rich indigenous fish in small-scale aquaculture (Wahab & Thilsted, 2002; Wahab et al., 2003). The gain BAU will achieve from the proposed project is continued support to activities within four research components: 1) aquaculture production of nutrient dense fish, 2) marketing and livelihood aspects of nutrient dense fish, 3) rice-field production of nutrient dense fish and 4) post-harvest processing. A core activity in the proposed project is the dissemination of an aquaculture production system of nutrient dense fish to poor, rural farmers. The extension system will be developed and disseminated in collaboration with the DANIDA supported aquaculture projects in Patuakhali and Noakhali (see Appendix 9) and non governmental organisations (NGOs) (Letters of Collaboration in Appendix 6). Research activities within marketing and post-harvest treatment of commonly consumed fish will be undertaken at BAU in the proposed project.

Cambodia

IFReDI is a new institute, established in 2002 under the DoF with support from DANIDA through the MRC. The mandate of IFReDI is to conduct research to provide the basis to be advisory for the government about inland fisheries. The contribution from IFReDI to the project is their knowledge and experience (transferred from DoF and MRC) in estimating fish production and developing management systems of the Mekong River Basin, one of the richest inland fisheries resources globally. The gain IFReDI will achieve from the proposed project is support to integrate food and nutrition security aspects in their research agenda. Research activities in fish consumption patterns and the nutritional value of commonly consumed fish will be supported by IHE and BAU. In a previous project (the frame work project Content and bioavailability of vitamin A, iron

and zinc in commonly consumed foods in developing countries), we screened 30 commonly consumed fish species for the contents of micronutrients. Nutrient dense indigenous fish species (with high vitamin A and haem iron contents) have been identified and these results will form the basis for further research activities. Strategies to enhance the availability and accessibility of nutrient dense fish species will be developed.

2.3 THE PROPOSED PROJECT

2.3.1 OVERALL AIM

The overall aim of the proposed project is to combat micronutrient deficiencies in developing countries through increasing the availability and accessibility of commonly consumed nutrient dense fish in ecologically and economically sustainable ways. Reduction in micronutrient malnutrition will contribute to improved food and nutrition security and hereby the livelihoods of poor population groups.

2.3.2 IMPLEMENTATION

The contribution from the proposed project to combat micronutrient deficiency

Commonly consumed foods are per se important for the food and nutrition security of a population. The proposed project will contribute to improve food and nutrition security through improving the quality of the every day diets of poor populations, with focus on the contribution of micronutrients from commonly consumed fish.

There is a large knowledge gap with respect to the nutritional contribution from commonly consumed fish in poor households. Based on knowledge on the nutritional value of commonly consumed fish, it is possible to develop fish production strategies which prioritise the nutritional benefits of specific fish species.

2.3.2.1 Research Activities

The proposed project will contribute to the development of strategies to enhance and / or protect the role of fish in food and nutrition security through activities in the fields of:

A) Research on the contribution of micronutrients from commonly consumed fish in poor households. This requires quantification of:

- a. fish consumption patterns (data on fish species in the diet, amount and frequency of consumption, edible parts of the fish, distribution between household members are required);
- b. contents of micronutrients in the commonly consumed fish species, in samples of raw, processed and cooked fish and (the nutrients in focus are vitamin A, iron, zinc and calcium); and
- c. the bioavailability of the micronutrients in focus, in order to evaluate the contribution of nutrients from fish to human nutrition.

B) Research to support strategies to enhance the availability and accessibility of fish with high nutritional value. This requires:

- a. development of site specific production strategies to enhance the production of nutrient dense fish species; and
- b. development of extension systems to disseminate new and improved production strategies.

C) Enhancing research capacity in the partner institutions in the fields of food and nutrition security. This will be supported through:

- a. human resource development (M.Sc. and Ph.D. studies);
- b. improvement in physical research resources; (for example laboratory facilities and equipment for field work); and
- c. exchange of expertise and experience between all partner institutions as well as the enhancement of linkages of the partner institutions to the international and national scientific community of food and nutrition security.

The specific activities in Bangladesh, Cambodia and Denmark are summarised in Tables 1 and 2.

Table 1. Summary of research activities (B=Bangladesh, C=Cambodia, D=Denmark.)

Research objective	Country	Activity	Output
Nutritional contribution from fish			
a) Assess fish consumption patterns in target population groups	C,	Consumption surveys integrated in socio-economic surveys	Data on fish consumption patterns
b) Nutrient content in raw, processed and cooked fish in commonly consumed dishes	B, C, D	C : sampling of raw, cooked and processed fish B: Experimental cooking and processing of fish D: Nutrient analyses	Data on nutrient content in raw, processed and cooked fish and fish meals
c) Bioavailability and metabolism of micronutrients in humans	D	in vitro studies of availability of iron and zinc in rice-fish and rice-beans dishes; preparation for in vivo studies on the metabolism and activity of vitamin A ₂	Data on the nutritional contribution of commonly consumed fish
Production and extension			
d) Production strategies for increased yield (availability) and marketing (accessibility) of nutrient dense fish species	B, C,	B: refinement of aquaculture production; further development of rice-field culture; survey on SIS marketing and livelihood; prediction of impact of increased	B: technology for carp-mola production ready to dissemination; data on SIS marketing; prediction of the impact of increased production of nutrient dense fish on

		production on marketing C : evaluation of the contribution of fish to food and nutrition security C : production strategies to be recommended / developed	marketing and livelihood C : Recommendations for strategies to increase the production of nutrient dense fish to be integrated in fisheries management
e) Development and dissemination of strategies to increase the intake of nutrient dense fish	B, C	B: dissemination of carp-mola culture technology through DANIDA supported fisheries components in Patuakhali and Noahkhali and NGOs. . C : strategies to be developed based on results from research activities in a, b and c	B: increased intake of nutrient dense fish in poor, rural households C: recommendations for strategies to increase the intake of nutrient dense fish to be integrated in fisheries management and nutritional programmes

Table 2. Summary of research capacity building activities in partner institutions (B=Bangladesh, C=Cambodia, D=Denmark)

Research capacity building objective	Country	Activity	Output
A) Human resource development in the field of food and nutrition security	B, C	Short-term training of staff in food and nutrition security and in methodologies for dietary assessment	Enhanced capacity of scientific staff to integrate food and nutrition security in the research agenda
		M.Sc. training of staff	
	C	Ph.D. training of staff (University of Philippines, Los Baños, for Cambodian candidate)	
B) Strengthen the physical facilities for conducting research in the field of food and nutrition security	B, C	Support to conduct field trials: transport, minor field and laboratory equipment	Enhanced physical capacity for working with research in food and nutrition security
C) Enhance the staff capacity to conduct research of international standard in the field of food and nutrition security	B, C	Support to develop research protocols; produce international publications and participate in international scientific meetings	Strengthen the international standing of the institution, including prospects for attracting research funding from donors

D) Support advanced data analyses to optimise the use of available data (data generated from this project as well as secondary data from other sources	B, C	Coaching and support in the analyses of fish production and consumption data in relation to food and nutrition security	Enhanced human capacity for survey planning and advanced data analyses, specifically in the field of integrating data on fish production, socio-economy, food consumption and nutrient content in fish
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Research Methods

The research methods are based on the expertise and experience of the staff at IHE and partner institutions as well as methods which have been used by other research groups and reported in scientific journals. Some methods are well established, while others need to be modified and refined. Briefly, the methods to be applied include:

A) The nutritional contribution from fish:

- a. conducting surveys of the fish consumption patterns in poor households and individuals in Cambodia. Field surveys will be conducted using a modified recall method combined with weighed records. IHE and BAU have the expertise and experience in these methods from previous projects (Hels et al., 2003a; Roos et al., 2003a; Nielsen et al., 2003). selection and sampling of fish and fish products for nutrient analyses will be conducted based on the guidelines developed at IHE (Roos et al., 2002);
- b. determination of the contents of micronutrients in fish will be conducted in laboratories at Danish institutions using appropriate methods such as atomic absorption spectrophotometry (AAS) and high performance liquid chromatography (HPLC). IHE, together with the Danish collaborating institutions have the expertise and equipment for these methods from previous projects (Hels et al. 2003b; Roos et al., 2002)
- c. conducting studies on the bioavailability of the micronutrients. These will be undertaken at IHE using established as well as new methods. Iron and zinc bioavailability will be studied in in vitro systems using the dialisability method and CaCo2 cells.
- d. developing a method using stable isotopes for studying vitamin A2 bioavailability and metabolism for in vivo studies in humans. The isotope method will be modified from studies on other vitamin A compounds to be undertaken at IHE.

B) Methods to develop strategies to improve the availability and accessibility of fish with high nutritional value

- a. Step 1: data analyses which combine existing knowledge in the partner institutions about fish production, management and economy of fisheries and aquaculture with the knowledge on nutritional contribution from fish, generated in this project. This has been done in Bangladesh (Thompson et al., 2002), and will be done in Cambodia.
- b. Step 2: identifying how and where the production of fish species of particular nutritional significance can be stimulated. In Bangladesh, an aquaculture production system has been developed to promote production of nutrient dense fish. In Cambodia, the focus is on fisheries rather than aquaculture.

- c. Step 3: planning intervention studies to survey the impact of a developed production strategy on fish consumption in target households and individuals. This has been completed in Bangladesh, and the experience can be used in Cambodia.
- d. Step 4: development of extension packages to disseminate the improved strategy in controlled field trials and in close collaboration with partners active in rural development (NGOs, government organisations and DANIDA funded fisheries components). Extension packages will include guidelines for training of extension staff, production manuals and information material about nutritional benefits. This can only be done when a production strategy has been developed, as is the case in Bangladesh.

C) The feasibility and viability of the project

The feasibility of the project is estimated to be high because the project is developed as a package of components which combines a) continued activities based on results and collaborative relations from previously successful *research* and *capacity building projects* and b) new research components which build on results from previous research. Also, the partners in the project, both old and new complement each other, forming a strong network which covers expertise and experience in different related disciplines and at different stages of development.

The viability of the project is also considered to be high, supported by the combination of old and new partners. BAU has moved into a phase of greater self reliance and the need for support to *research capacity building* has decreased. Focus will be given to dissemination of results to end-users (farmers). IFRaDI is young and lacks senior experience, but on-going institutional capacity building supported by DANIDA and Asian Development Bank is strengthening the institution to conduct advanced research activities. KMFRI is a well-established research institution which has the capability of integrating new research fields in a viable manner.

D) Risks and assumptions

The risks for failure of the proposed project are estimated to be low. The project is based on the assumption that qualified and committed manpower is present in the partner institutions throughout the project period.

E) Indicators for measuring outputs

The *research* activities in Denmark and partner countries will be measured by:

- a. scientific production based on publications in peer reviewed international journals, contributions to international scientific meetings and conferences and development of research methodologies
- b. the contribution to national fisheries development policies and strategies in Bangladesh and Cambodia
- c. the contribution to recommendations to DANIDA's sector programmes

The *research capacity building* activities in Bangladesh and Cambodia will be measured by:

- a. increased human resource capacity such as short term training of staff, M.Sc. and Ph.D. studies

- b. the improvement in physical research resources such as equipment for field and laboratory work
- c. exchange of expertise and experience between all partner institutions as well as the enhancement of linkages of the partner institutions to the international and national scientific networks in the field of food and nutrition security

F) Dissemination of the results

The results from the research in the proposed project will be published in international peer reviewed journals as well as national journals. In addition, the results will be disseminated to policy makers, government organisations, bilateral agencies, especially DANIDA, NGOs in the fields of fisheries and aquaculture and food and nutrition security as well as poor, rural households who produce fish. This will be done through workshops and meetings as well as training of field staff.

2.3.2.2 Research capacity building in partner institutions

At the preparatory workshop held in October 2003, the research capacity needs in partner institutions were identified.

BAU in Bangladesh

BAU has been a partner institution in the "Food and nutrition security ENRECA project" through which strengthened capacity in the following fields has achieved: 1) human resource capacity (one completed Ph.D. study, 2 on-going Ph.D. study, 10 M.Sc.studies); 2) laboratory facilities and 3) publication of 20 papers. The ENRECA project is being phased out in 2004 and the support to research capacity building will continue in the proposed project. Further support is needed in the fields of:

- a. training of staff and students in integrating food and nutrition security within fisheries research through M.Sc.studies. Four permanent staff members are now involved in project-related research. The immediate need for Ph.D. studies has been met through the ENRECA project
- b. upgrading the physical facilities to conduct research, particularly on-farm trials and field surveys
- c. improving the quality of the research to international standards

IFReDI in Cambodia

IFReDI has selected a number of priority areas for research, of which "Food production and food security" ranks among the highest. The capacity gap identified to be met by the proposed project is improvement of the human resource capacity for research in general. The support to enhanced *research capacity building* will be in the fields of:

A) Human resource development

- a. M.Sc. and Ph.D. training
- b. short term training courses in dietary assessment methodology
- c. short term training courses in the development of research protocols for experimental processing of fish

- d. training courses in advanced socio-economic survey planning and data analyses. This will be implemented in collaboration with the IFM through coaching and training by IFM senior staff. IFM is experienced in socio-economic research related to fisheries and has more than ten years of working experience in the Mekong region

B) Physical research capacity through the supply of minor equipment for field surveys and laboratory analyses

C) Links to the international research environment and relevant networks through

- a. network formation within the project as well as with associated partners
- b. collaboration with the project "Fishborne Zoonotic Parasites in Vietnam (FIBOZOPA)" in Vietnam is established (MoU in Appendix 6). This project is being implemented in close collaboration with the Fishery Sector Programme Support (FSPS) in Vietnam with the support from the RUF. Through this collaboration, the project will be linked to the FSPS in Vietnam.