Genetic management and improvement strategies for exotic carps in Asia: a project overview

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Penman, D.J., Mair, G.C., McAndrew, B.J., Hussain, M.G., Sattar, M.A., Basavaraju, Y. and Tuan, P.A. 2002. Genetic management and improvement strategies for exotic carps in Asia: a project overview. pp. 1-8. In: Penman, D.J., Hussain, M.G., McAndrew, B.J. and Mazid, M.A. (eds.). Proceedings of a workshop on Genetic Management and Improvement Strategies for Exotic Carps in Asia, 12-14 February 2002, Dhaka, Bangladesh. Bangladesh Fisheries Research Institute, Mymensingh, Bangladesh. xxx p.

The project which is the focus of this workshop, which is funded by the DFID Aquaculture and Fish Genetics Research Programme (AFGRP: project R7590), was developed to address the common theme of management of exotic (non-indigenous) carp species in Asian aquaculture. It began in April 2000. In this brief overview, we address some of the key issues the project is dealing with. More information on specific project activities can be found in other papers in the workshop proceedings

(Hussain and Mazid; Sattar and Das; Mia *et al.*, Kohinoor *et al.*; Basavaraju *et al.*; Mair and Tuan) and in the project logical framework, which follows this overview.

Of the fish species cultured in Asia, it is most often carps and tilapias which make contributions to the livelihoods of poor people, through farming, consumption and associated activities. Carps feed low down in the food chain, making them suitable for low input aquaculture and for many species the market prices are fairly low, making them affordable as a source of protein for poor people.

Although the project is not promoting the introduction of non-indigenous species for aquaculture, realistically it is accepted that several such species do make important contributions to aquaculture in Asia and to the livelihoods of the poorer sectors of society. While the genetic management and improvement of stocks of all species in aquaculture is important to sustain and improve production, particular problems are presented in the case of non-indigenous species. The founder stocks may have been of poor, or unknown, quality. For example, some of the stocks of Chinese carps originally introduced into Bangladesh were secondary or tertiary transfers from countries other than China, although more recent introductions came straight from wild stocks in China. Small numbers of parent fish contributing to an introduction, or low survival/breeding rate among the introduced fish, may lead to poor performance through low genetic variation (bottlenecking) or a genetic makeup which is unrepresentative of the parent population (founder effect). For indigenous species, it is often possible, if necessary, to go back to local wild populations to replenish hatchery stocks, for example if a decline in performance is observed or suspected. For non-indigenous species, logistical and political factors may make this difficult, along with associated risks of introducing pathogens or other undesirable species. In tackling the particular problems of managing introduced species, we also hope to be able to promote the more general message of good genetic management of aquaculture broodstocks, which is often neglected.

Genetics is sometimes seen as a highly technical subject of little relevance to "real life". However, we believe that in the context of broodstock management, genetics is highly relevant to the livelihoods of stakeholders in aquaculture (hatcheries, nurseries, traders, on-growers, consumers), and that appropriate research in aquaculture genetics can play a strong role in sustaining and improving livelihoods. The breeding of fish in hatcheries is not isolated from the rest of aquaculture. The seed produced in hatcheries work their way right through the network of nurseries, traders, on-growers and markets to consumers, and changes in the genetic quality of those seed will likewise have effects throughout this network. Some networks may be local, while others are far reaching both in geographical terms and in terms of the different socioeconomic groups who are linked through the network. For example,

large private carp hatcheries in Jessore in SW Bangladesh are the source of much of the fish seed supply to small-scale ongrowers in NW Bangladesh, one of the poorest regions of the country.

In addition to seed leaving hatcheries, there should also be a flow of information from the rest of aquaculture back to the hatcheries, to feed into the process of good broodstock management by, for example, defining important traits or identifying superior stocks. Too often, this link is missing. In the absence of good genetic management of hatchery stocks or where management considerations are entirely "internal", for example where a numerical seed target is the main objective and broodstock replacement is from leftover fish, changes in genetic quality of seed are likely to be negative (through inbreeding or negative selection). Good broodstock management, ideally taking into account information from performance during on-growing on farms, will result in sustained or improved quality of broodstock and seed produced for aquaculture (e.g. as a result of good stock choice, prevention of inbreeding, planned selection or monosex fry production). Inbreeding has negative effects on many traits of interest to aquaculture (growth rate, survival rate, deformities, etc). Planned selection, however, generally focuses on only one or a few traits. While "growth rate" is the most common trait initially targeted in selective breeding, this has to be more carefully defined. Does it mean faster growth on unlimited resources or faster growth on fixed resources? The latter (i.e. increases in production efficiency) is likely to be more important to resource-poor fish farmers. We are trying to involve such farmers in defining appropriate traits for selective breeding, and there is evidence of the benefits of such an approach from other agricultural crops.

While we can try to develop improved stocks for aquaculture and implement other changes at a local level, to have sustainable impact the project also needs to influence policy at state, national and international levels. This can mean supporting the implementation of improved broodstock management practices which will lead to sustainability of and improvements in seed quality at state or national level (as is already taking place for example with the Karnataka State Department of Fisheries in India). On a broader scale, links through international bodies such as INGA, the International Network for Genetics in Aquaculture, can help to spread knowledge and other project outputs more widely. INGA is coordinated by ICLARM, has member countries in Asia and Africa and also several associated Advanced Scientific Institute members. All of the institutes involved in the DFID project are members or associate members of INGA and participate in its activities.

In summary, we hope that through this project we will demonstrate that it is possible, in the medium to long term, to impact positively upon sustainable livelihoods through the appropriate application of genetics based methods focussed on basic broodstock management and on traits important to the target stakeholders. We believe this impact will come directly through application of knowledge and improved fish stocks and indirectly through influence on policy. Links to related initiatives such as the INGA-coordinated ABD carp genetics project and the AFGRP-funded seed quality in Asia project (R7052) will also be important in achieving impact and developing appropriate further research.

Acknowledgement
We would like to thank DFID for the funding of this project, through the Aquaculture and Fish Genetics Research Programme, which is managed by Prof. James Muir at the Institute of Aquaculture, University of Stirling.

Logistical Framework for DFID-AFGRP project R7590: **Genetic management and improvement strategies for exotic carps in Asia**

Narrative Summary	**Objectively Verifiable Indicators (OVI)**	**Means of Verification**	**Important Assumptions**
GOAL: Productive benefits of aquatic resources for poor people generated and sustained through improved knowledge of aquatic stocks and their selection, enhancement and culture.	By 2005, knowledge gains allow 500,000 poor people in S & SE Asia to improve food supply by 20% and income by 20%, based on yield increases related to better aquatic stocks, sustainable aquaculture and enhancement practices, and at least 100,000 people positively impacted by development activities incorporating programme outputs.	- National, FAO fisheries/aquaculture sector surveys and statistics, environment report - Evaluation of RNRKS and AFGRP - National reports to regional organisations.- reports of target institutions/key locations - Household and community surveys/ monitoring against base-line data.	Poor people invest benefits to improve livelihoods
PURPOSE: Strategies for genetic management and improvement of cultured exotic carp species in low input aquaculture systems developed, verified and recommended for adoption in Bangladesh, India and Vietnam and potential impact of improved fish on livelihoods demonstrated.	- Best stocks identified and strategies formulated by end of project - Upstream and downstream output to uptake pathways clearly identified at project end - Management tools and recommendations adopted and implemented by 2005 - Recommended and improved stocks widely adopted for aquaculture by 2007	Government and other official reports and statistics, project documentation and post project surveys.	- Enabling environments for widespread adoption of new technologies and strategies exist. - Climatic conditions remain favourable. Agencies responsible for dissemination of project outputs can appropriately target strategies at poor people.

OUTPUTS: 1. Strategies for genetic management and improvement of carp stocks developed and recommended 2. Superior stocks of carps for low input aquaculture systems identified and/or developed 3. Examples of improvements in production levels demonstrated in low-input aquaculture systems incorporating carps 4. Preliminary assessment of potential impact of production and genetic improvements on livelihoods 5. Scientific tools incorporating genetic markers for sustainable genetic management of Common and Chinese carps 6. Live and cryopreserved (sperm) gene bank of base strains for cultured exotic carps in Bangladesh, India and Vietnam.	1. Workshops held at which the appropriate strategies are recommended to relevant national agencies by end of project. 2. Performance characterisation of available stocks of relevant carp species completed by the end of Year 3. 3. Average of 20% improvement in yields of relevant species or systems demonstrated in trials by the end of the project. 4. Basic livelihood indicators assessed in all farm based trials 5. Genetic markers appropriate for monitoring genetic variation in hatchery broodstock of Chinese carps and some common carps developed and verified by the end of the project. 6. Viable sperm banks developed in appropriate institutions by the end of year 3	Project reports and publications, based on research carried out in the laboratory, on-station and on-farm	Social, economic and political environment remains suitable for the adoption, implementation and sustainable utilisation of project outputs.

ACTIVITIES: 1. 1.1. Development of appropriate broodstock management and dissemination strategies and formulation of recommendations based on characterisation of culture performance and genetic variation. 1.2. Recommendations presented and modified at workshop(s) 2. 2.1. Introduction, where necessary, of new carp strains 2.2. Optimise tagging and marking methods for strain identification in these species and develop protocols for researcher led and farmer led growth trials for strain comparisons 2.3. Evaluation of comparative culture performance and yield of carp stocks in on-station and on-farm trials including, where appropriate, assessment of heterosis and genotype x environment interactions 3. On-station and on farm evaluation of superior and existing stocks in polyculture.	1. Recommendations formulated and presented at workshop(s) in the final year of the project 2. 2.1. New strains introduced by end of year 1 2.2. Methods developed and optimised by the end of year 1 (on-station) and year 3 (on-farm) 2.3. Comprehensive on-station and on-farm and trials completed by end of year 3 3. Production evaluated in minimum of two on-station and four on-farm trials in each country by end of project	Project reports	- Cooperation between institutions is maintained and develops appropriately - Collection and local adaptation of newly acquired strains is successful - Work is not disrupted by natural disasters or personnel changes - Molecular markers can be developed in predicted timescale - Adequate information is available on social and economic aspects of dissemination and targetted beneficiaries

ACTIVITIES (contd.): 4. Participatory evaluation of impacts of superior stocks on livelihoods indicators of beneficiary farmers 5. Development and application of a suite of polymorphic DNA markers to Chinese carps and application of existing DNA markers to Vietnamese common carp. 6. Cryopreservation of sperm from base populations of all available strains and transfer of frozen samples to appropriate locations.	4. Assessment of livelihood indicators for all on-farm production trials. 5. 5.1. At least 5 markers with moderate to high polymorphism levels developed for each species of Chinese carps by end of year 2 5.2. Genetic variation in Bangladeshi & Vietnamese stocks of Chinese carps & Vietnamese common carp compared and applied to understanding genetic basis of performance differences by end of year 3 5.3. Verify the application of molecular tools to broodstock management and dissemination strategies by the end of the project 6. Cryopreservation of sperm from base populations of all available strains and transfer of frozen samples to appropriate locations by mid of year 3	Project reports	- Cooperation between institutions is maintained and develops appropriately - Collection and local adaptation of newly acquired strains is successful - Work is not disrupted by natural disasters or personnel changes - Molecular markers can be developed in predicted timescale - Adequate information is available on social and economic aspects of dissemination and targetted beneficiaries