Fish genetic networks boost production

RIU

Validated RNRRS Output.

Networks to promote high-quality breeding fish are the key to profitable aquaculture, especially for poor producers. In some countries breeding fish for aquaculture is managed so poorly that farmers produce less and less. Breeding quality fish for aquaculture can be highly successful but still has a long way to go in many developing countries. Networks to improve fish genetics—and thus production—bring together government, university and private organisations locally, nationally and internationally. They are already thriving and, in some cases, expanding in South Africa, Vietnam, Bangladesh, India and Thailand. The various mixes of public, private commercial, NGO and poor producers in these networks show great promise as models for improving not only fish production but also other commodities.

Project Ref: **AFGP09:**
Topic: **3. Improving Fishers Livelihoods: Better Fishing Management & Aquaculture**
Lead Organisation: **University of Stirling, UK**
Source: **Aquaculture & Fish Genetics Research Programme**

Document Contents:

Description

Research into Use
NR International
Park House
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UK

Geographical regions included:

Bangladesh, India, Philippines, South Africa, Thailand, Vietnam,

Target Audiences for this content:

Fishers,

AFGP09

A. Description of the research output(s)

1. Working title of output or cluster of outputs.
In addition, you are free to suggest a shorter more imaginative working title/acronym of 20 words or less.

Networks for genetic management in aquaculture and stocked fisheries for biodiversity and production gain to meet food supply and environmental quality goals.

Aquatic genetic management networks

2. Name of relevant RNRRS Programme(s) commissioning supporting research and also indicate other funding sources, if applicable.

Aquaculture and Fish Genetics Research Programme

3. Provide relevant R numbers (and/or programme development/dissemination reference numbers covering supporting research) along with the institutional partners (with individual contact persons (if appropriate)) involved in the project activities. As with the question above, this is primarily to allow for the legacy of the RNRRS to be acknowledged during the RIUP activities.

R7590, R7284, W06, W07

UK - University of Stirling (R7590), University of Wales, Swansea (R7284)
India UASB (R7590)
Bangladesh: BFRF; BFRI; BRAC (R7590)
Vietnam RIA 1; Ministry of Fisheries (R7590)
South Africa: University of Stellenbosch (R7284)
Regional Asia/ Thailand – AIT, NACA, WorldFish, FAO (R7590, W06)
Regional Africa – WorldFish, FAO (R7284, W07)

*4. Describe the RNRRS output or cluster of outputs being proposed and when was it produced? **(max. 400 words)**. This requires a clear and concise description of the output(s) and the problem the output(s) aimed to address. Please incorporate and highlight (in bold) key words that would/could be used to select your output when held in a database.*

Genetic management and improvement of **aquatic stocks** for **aquaculture** and **biodiversity** purposes is still at an early stage in many developing countries, although fairly sophisticated **selective breeding** programmes for aquaculture have been developed elsewhere (e.g. for Atlantic salmon). In some situations in developing countries genetic management of captive stocks is so poor that declines in performance are seen over time, and wild stocks are often regarded locally as genetically superior to most captive stocks. DFID-AFGRP projects have developed methodologies for assessment of different stocks (e.g. from different wild sources, local hatcheries or more widespread sources) for aquaculture, genetic management of captive stocks (to maintain genetic quality and minimise inbreeding, applicable to aquaculture, fisheries enhancement and conservation), and genetic

improvement of stocks for aquaculture (using approaches tailored to local resources). A novel aspect of **aquaculture genetics** is the ability to produce **monosex populations** (all-male or all-female), where one sex performs better than the other or to limit reproduction among culture fish where this reduces performance. Techniques for monosex production have been developed and applied in DFID-AFGRP projects in developing countries in species of tilapias and cyprinids.

Specific products of DFID-AFGRP projects are:

1) Genetically male Nile and Mozambique **tilapia.** Males grow faster and monosex or near-monosex populations do not breed during ongrowing, preventing unwanted fry production which limits harvest size;
2) Monosex female silver barbs. Female silver barbs grow faster than males and in some countries the ovaries of mature females are a delicacy;
3) A **breeding programme** for **improved harvest weight** in common **carp** is underway in Karnataka, India. This was developed from a synthetic base population after assessment of the performance of several different stocks;
4) A strategic management programme for Chinese carp stocks in Bangladesh, brought from the Yangtze River following widespread reports of problems in existing stocks. This included assessment of stocks, local capacity building, and a protocol developed and disseminated for public, private and NGO sector partnerships for genetic management to maintain quality and diversity;
4) A range of **methodologies** and **networks** have been developed to implement and disseminate the programmes described above. These networks have involved a variety of governmental, University and private institutes at the local, state, national and international levels, and are potentially applicable to a wider range of aquaculture stocks and resource/production environments.

5. What is the type of output(s) being described here?
Please tick one or more of the following options.

Product	***Technology***	***Service***	***Process or Methodology***	***Policy***	***Other Please specify***
x	*x*	*x*	*x*	*x*	

This output covers a suite of approaches that can be adapted according to the needs of each network.

6. What is the main commodity (ies) upon which the output(s) focussed? Could this output be applied to other commodities, if so, please comment

Aquatic organisms.

7. What production system(s) does/could the output(s) focus upon?
Please tick one or more of the following options. Leave blank if not applicable

Semi-Arid	***High potential***	***Hillsides***	***Forest-Agriculture***	***Peri-urban***	***Land water***	***Tropical moist forest***	***Cross-cutting***
x	*x*	*x*		*x*	*x*		*x*

This output would be appropriate wherever aquatic stocks are distributed, but clearly most appropriate in major productive regions.

8. What farming system(s) does the output(s) focus upon?
Please tick one or more of the following options (see Annex B for definitions).
Leave blank if not applicable

Smallholder rainfed humid	***Irrigated***	***Wetland rice based***	***Smallholder rainfed highland***	***Smallholder rainfed dry/cold***	***Dualistic***	***Coastal artisanal fishing***
x	*x*	*x*	*x*	*x*	*x*	*x*

This output has potential in all farming systems where a holistic approach to the improvement aquatic stocks would be beneficial.

*9. How could value be added to the output or additional constraints faced by poor people addressed by clustering this output with research outputs from other sources (RNRRS and non RNRRS)? (**max. 300 words**).*

Please specify what other outputs your output(s) could be clustered. At this point you should make reference to the circulated list of RNRRS outputs for which proformas are currently being prepared.

This output could be clustered with the following proformas from the Plant Sciences Research Programme - Generic Themes: PVS (Participatory Varietal Selection); COB (Client-oriented breeding); Community-based seed production and distribution (CBSPD).

In addition to the technical issues addressed in this output, the information and management models involved contains services and lessons that could be shared across systems. The various mixes of public, private commercial, NGO and poor producer involvement in these networks is a potential model for other commodities.

Diverse integrated approaches to agriculture necessitate the multipurpose use of water. This is particularly important for poorer users who tend to be more likely to use water for multiple/integrated purposes. In areas where farmers have diverse agricultural strategies that include aquatic animals it would be worthwhile conducting trials/improved strain development on more than one crop at a time, especially where the organisms in question are grown in an integrated manner. Including a programme for the selective improvement of aquatic animals could potentially increase the productivity of these waters.

Validation

B. Validation of the research output(s)

*10**. How** were the output(s) validated and **who** validated them?*

Please provide brief description of method(s) used and consider application, replication, adaptation and/or adoption in the context of any partner organisation and user groups involved. In addressing the "who" component detail which group(s) did the validation e.g. end users, intermediary organisation, government department, aid organisation, private company etc... This section should also be used to detail, if applicable, to which social group, gender, income category the validation was applied and any increases in productivity observed during validation ***(max. 500 words)****.*

Having a diverse range of stakeholders facilitated appropriate development of strains because of selection of key production traits relevant to poor producers needs early in the process. These traits were selected for through breeding programmes on government research stations and tested in on-station trials. Those considered viable were further tested with potential producers in on-farm trials. Feedback from the farmers was used in the refinement of stocks that were further trialled on-station and on-farm before being initially taken up by moderate poor farmers in research areas.

These improved strains have been adopted within regular production strategies. Promotion of improved strains has been done by government departments and universities, with some assistance from intermediary organisations interested in acquiring improved strains for their clients. In India governments of other states have requested improved stocks, in South Africa the improved stock was the subject of a challenge fund application that encouraged commercial adoption whilst ensuring effective production systems for extreme poor groups. In Thailand monosex female silver barb production was adopted by commercial hatcheries and moderate poor ongrowers.

Crucially the networks engaged in these outputs have been sustained and in some cases expanded since research ceased. The link between researchers and farmers has been an essential driver in maintaining these networks.

11. ***Where and when*** *have the output(s) been validated?*

Please indicate the places(s) and country(ies), any particular social group targeted and also indicate in which production system and farming system, using the options provided in questions 7 and 8 respectively, above ***(max 300 words)****.*

The formation of networks for genetic management has been validated in South Africa, Vietnam, Bangladesh, Karnataka in India and Thailand. In each of these countries there is a range of farming systems with potential to benefit from improved fish strains, but to date research has specifically targeted selected production systems in each location. There is scope for much wider uptake.

Karnataka in India offers high potential opportunities because smallholder rainfed farming necessitates the construction of abundant water storage facilities. This network approach was validated in 2004. Common carp improved for this environment have recently (2006) been requested for the highland, cooler environments of Himanchal Pradesh in India.

Early stages of these outputs, e.g. monosex silver barb and improved tilapia, were in use in the late 1990s, but in most partner countries the validation process is still on-going through continued use and demand.

Current Situation

C. Current situation

*12. **How and by whom** are the outputs currently being used? Please give a brief description **(max. 250 words**).*

In areas where the original research took place, National Broodstock Centres are supporting expansion of aquaculture by producing and disseminating high quality broodstock and seed to moderate and extreme vulnerable poor farmers. There is significant scope to multiply these outputs.

Genetically Male Tilapia (GMT) is now a recognised product and is used.significantly by moderate poor farmers, particularly where the original research took place.

Within and immediately surrounding the research areas formal and informal networks of government and private hatcheries continue to maintain broodstock and supply moderate and extreme vulnerable poor farmers with improved fish seed.

Monosex female silver barb production used commercially by private hatcheries and moderate poor ongrowers.

*13. **Where** are the outputs currently being used? As with Question 11 please indicate place(s) and countries where the outputs are being used **(max. 250 words).***

Improved common carp breeding programme continues in Karnataka, India, but is also being spread to other states in India, e.g. Himanchal Pradesh.

Selected Chinese carp stocks at the government hatchery in Parbatipur, Bangladesh are being disseminated on a very limited scale as stock fish to local hatcheries as well as supplying seed to extreme vulnerable poor and moderate poor farmers.

Genetically Male Tilapia (GMT) is used in the Philippines in irrigated and wetland rice based farming systems.

The use of monosex female silver barb production has not spread much beyond the area in Thailand where it was developed.

*14. What is the scale of current use? Indicating how quickly use was established and whether usage is still spreading **(max 250 words).***

Networks for genetic management for biodiversity and production gain have been established in a few selected places within the countries where the original research took place. Some replication is starting to become apparent in one or two other states in India, for example, but essentially there is still potential to link together a wider range of stakeholders within the countries where these networks exist and to develop networks for many other countries where there is aquaculture production.

15. In your experience what programmes, platforms, policy, institutional structures exist that have assisted with the promotion and/or adoption of the output(s) proposed here and in terms of capacity strengthening what do you see as the key facts of success? ***(max 350 words).***

It is critical to have an enabling policy environment to facilitate establishment of these networks because government agencies are typically central to the adoption of improved products. However, in an increasingly market driven economy it will be important to ensure liberal opportunities for commercial exploitation of improved fish strains in order to ensure viability and best prices for moderate and extreme vulnerable poor end users.

As food demand and international competition grow it will become increasingly important to ensure sustainable economic benefits from ecosystems under increasing pressure. It will be critical to have strong networks and processes in place to capitalise on new opportunities from dwindling resources.

One key capacity issue is the ability to manage stocks to ensure maintenance of genetic quality. Key staff will require training in these approaches. A strong network will use a mix of government stations and accredited hatcheries being jointly responsible for the maintenance of seed quality.

Current Promotion

D. Current promotion/uptake pathways

16. ***Where*** *is promotion currently taking place? Please indicate for each country specified detail what promotion is taking place, by whom and indicate the scale of current promotion* ***(max 200 words).***

In India the lead university partner is promoting improved carp strains to other institutions in national workshops. Locally information on improved strains is promoted to farmers through posters and fisheries officers' field visits, but constrained by limited budgets.

In Vietnam the Ministry of Fisheries is promoting National Broodstock Centres through local government extension offices and national media.

In Thailand, Bangladesh, India and Vietnam commercial partners promote improved strains and the networks that maintain them through sale to farmers.

17. What are the current barriers preventing or slowing the adoption of the output(s)? Cover here institutional issues, those relating to policy, marketing, infrastructure, social exclusion etc. ***(max 200 words)****.*

Limited local resource inputs through government structures are restricting uptake in some locations.

When establishing networks it is important to ensure all partners have a clear understanding of their role and

what they could potentially gain from the network. Where this has not been clearly established competition has become apparent between partners and it has not been possible to effectively maintain the programme.

18. What changes are needed to remove/reduce these barriers to adoption? This section could be used to identify perceived capacity related issues ***(max 200 words).***

More benefit could arise if more resources were available to scale-up and properly embed in wider production/ management systems or where networks included greater emphasis on commercial partners.

Clear and open dialogue from the start and if necessary governmental or commercial pressure to correct the conflict.

19. What lessons have you learnt about the best ways to get the outputs used by the largest number of poor people? ***(max 300 words).***

A medium to long term outlook is required as the development of networks and the improved strains they may produce can take years to achieve and require significant investments in time and money. An improved seed, once made widely available through an active commercial network will sell itself because of improved performance in local conditions.

Impacts on Poverty

E. Impacts on poverty to date

20. Where have impact studies on poverty in relation to this output or cluster of outputs taken place? This should include any formal poverty impact studies (and it is appreciated that these will not be commonplace) and any less formal studies including any poverty mapping-type or monitoring work which allow for some analysis on impact on poverty to be made. Details of any cost-benefit analyses may also be detailed at this point. Please list studies here.

Studies on impact have been conducted in India, Philippines and South Africa. In the Luzon, Philippines a formal project (R6937) assessed the adoption of GMT tilapia around the research area, considering aspects of gender and wellbeing.

In Karnataka, India informal studies have been conducted since original project completion as part dissemination and uptake programme development funding.
In South Africa a brief assessment was made during the application for a challenge fund project.

There is a lack of impact studies on genetic gains from better management strategies, but AFGRP has commissioned some project related papers.

21. Based on the evidence in the studies listed above, for each country detail how the poor have benefited from the application and/or adoption of the output(s) ***(max. 500 words):***

- *What positive impacts on livelihoods have been recorded and over what time period have these impacts been observed? These impacts should be recorded against the capital assets (human, social, natural, physical and, financial) of the livelihoods framework;*
- *For whom i.e. which type of person (gender, poverty group (see glossary for definitions) has there been a positive impact;*
- *Indicate the number of people who have realised a positive impact on their livelihood;*
- *Using whatever appropriate indicator was used detail what was the average percentage increase recorded*

Increased financial capital has been recorded for around 3000 moderate and vulnerable poor producers in the Philippines because of improved growth and subsequent market returns when growing the improved strain of around 20%.

In India around 500 farmers are now growing the improved common carp strain promoted by the network. Because of its improved fitness in that environment the farmers are seeing returns on their investment about a month earlier than previously seen.

In South Africa the adoption of improved strains of local tilapias has been limited because returns are still low compared to other practices, but crucially it is the extreme vulnerable poor who have adopted the technology.

Genetic management strategies offer clear opportunities for impact through increases in human capital from knowledge sharing, social capital through network inclusion, natural capital through more efficient resource use, physical capital through improved production infrastructures and financial capital through increased returns to labour. These benefits can be seen at the household, organisational and national levels.

Environmental Impact

H. Environmental impact

24. What are the direct and indirect environmental benefits related to the output(s) and their outcome(s)? ***(max 300 words)***

This could include direct benefits from the application of the technology or policy action with local governments or multinational agencies to create environmentally sound policies or programmes. Any supporting and appropriate evidence can be provided in the form of an annex.

Avoiding production and dispersal of poor strains, used for or potrentially capable of dispersal into open waters.

Producing strains that are more efficient at converting food and can be grown more effectively in facilities that utilise water and land resources more efficiently will directly reduce any potential environmental impact from aquaculture production.

By developing selectively bred local strains there is less environmental risk from the introduction of exotic strains.

25. Are there any adverse environmental impacts related to the output(s) and their outcome(s)? ***(max 100 words)***

For aquaculture it would be advisable to focus on production of strains that would not interfere with native wild stocks if accidentally released into the environment.

26. Do the outputs increase the capacity of poor people to cope with the effects of climate change, reduce the risks of natural disasters and increase their resilience? ***(max 200 words)***

Yes. Selective breeding can potentially offer the producer stocks that more closely match local environmental conditions and could be more resilient to shocks. A further example would be a faster growing strain that could reach an acceptable market size in a shorter time, therefore potentially avoiding drought or flood periods.
