Household hatcheries are a major breakthrough in small-scale fish farming

RIU

Validated RNRRS Output.

Low-cost household hatcheries for carp and tilapia are helping farmers take up small-scale aquaculture. Previously, the supply of good quality fish fingerlings was a major hurdle. Central hatcheries couldn't cater to far-flung customers. Now, with just a little training, rural households can learn to raise good quality fish fingerlings. As well as stocking their own paddies and ponds, farmers have young fish to eat or sell. In Bangladesh and the hilly regions of northern Vietnam, these decentralised household hatcheries have led thousands of rural poor to start small-scale aquaculture in fields, ditches or ponds. The potential for household hatcheries for other species, both freshwater and marine, and for all regions where there are small water bodies, is enormous.

Project Ref: **AFGP01:**
Topic: **3. Improving Fishers Livelihoods: Better Fishing Management & Aquaculture**
Lead Organisation: **University of Stirling, UK**
Source: **Aquaculture & Fish Genetics Research Programme**

Document Contents:

Description

AFGP01

Research into Use
NR International
Park House
Bradbourne Lane
Aylesford
Kent
ME20 6SN
UK

Geographical regions included:

Bangladesh, Vietnam,

Target Audiences for this content:

Fishers,

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.

Partnerships in aquatic seed: Developing quality seed networks for diversified and profitable aquaculture

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

Aquaculture and Fish Genetics Research Programme

Linked in to earlier funding sources: CARE Bangladesh

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.

R7052: Fish Seed Quality in Asia (Improving freshwater fish seed supply and performance in smallholder aquaculture systems)

Institutional partners: WorldFish Center – Bangladesh and South Asia Office, Bangladesh Agricultural University (BAU); University of Sussex, UK, CARE Bangladesh; and Bangladesh Fisheries Research Forum

*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.*

Throughout the developing world large public sector hatcheries have historically been the primary source of seed. The poor quality and availability of **fish seed** that frequently result are considered to have hindered the adoption of **aquaculture** in many of these locations. Smaller-scale **decentralised** private seed production is found to be a key driver in Asian countries where aquaculture has become an important and widely practiced livelihood. Centralised **hatcheries** cannot effectively serve many otherwise promising rural areas due to extended travel required to reach them. This has negative impacts on seed cost, quality and supply, and acts as a barrier to further development of aquaculture. Even in areas where reliable seed supply exists, a lack of access to suitable land and water resources and relatively high start-up, operational and opportunity costs may prohibit adoption of much traditional semi-intensive aquaculture by the poorest members of society. Decentralised production of seed at the household level removes a number of critical restrictions to small-scale aquaculture development, and in doing so can bring about substantial gains in food security and income among adopters. Production of common carp and tilapia fry and fingerlings in rice fields in Bangladesh has been shown to create a range of important benefits. Given appropriate knowledge seed production can be adopted at very little or no cost to small-scale

farmers. Fingerlings can be produced within a short timeframe for restocking, sale, or use as food. This has been proven to substantially increase overall system productivity and augment incomes, particularly during the most severe periods of seasonal vulnerability. Other associated benefits include reduced pesticide application, increased harvests of wild species from **rice field ecosystems**, and more sustainable and efficient use of water. Adoption of this technology is most appropriate to, and pronounced among, the poorest farming groups and the potential for widespread secondary adoption has started to be recognised.

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*	

The nature of this output depends on the context and need to which it is applied. For instance, in some cases policy support for decentralisation of seed production may be appropriate, whilst in others provision of services to promote private initiatives may be required. It produces a product (fish seed) via application of a simple process.

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

The major commodity on which the output focuses is fish, specifically tilapia and common carp fry, fingerlings and mature fish. There is also potential for applying decentralised production to other aquatic species such as giant freshwater prawn

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*	*X*	*X*

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*

Production of fingerlings in rice fields derives primarily from wetland rice based, irrigated and smallholder rainfed humid farming systems but has possible applications in smallholder rainfed highland areas. As a general concept decentralised seed production is potentially applicable to all of the categories listed.

*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.

Because it takes place in rice fields decentralised seed production as practiced in Bangladesh could add value to the outputs 'Weed management in irrigated rice', 'Cost effective weed management packages for lowland rice in Bangladesh', and 'Pest management tools and strategies'. Fish stocked in rice field play an important role in reducing the incidence of pests and unwanted aquatic vegetation. The outputs might therefore be clustered together. It is similarly relevant to the output 'Managing rice pests in Bangladesh by improving extension service information management for policy and planning'. These four outputs could be delivered as part of a strategy focussing on enhancing rice based farming systems. The 'Bangladesh: Integrated Floodplain Management' output might also fall into this category. The 'Community-based seed production and distribution (CBSPD)' output also links directly to the production of fish seed in this way. More broadly, with regard decentralised fish seed production in a variety of systems, the 'PVS (Participatory Varietal Selection)' and 'COB (Client-oriented breeding)' outputs could be used to enhance decentralised seed production in for numerous species.

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)**.*

Rice field seed production techniques have been applied by CARE Bangladesh since 1993. AFGRP involvement from 2000 onwards introduced Nile tilapia to a system previously based only on common carp production. Introduction of tilapia changed the management and outcomes of rice-field based seed fish production dramatically. Previously common carp seed production was a low level, subsistence orientated activity. After introduction of Nile tilapia, more than 80% of participating households sold some of the large-sized seed in addition to using it to restock their own systems and for direct consumption. Small numbers of tilapia brood fish are stocked along with common carp eggs taken from small community water bodies in rice fields close to the homestead. These produce quickly produce fry which can be harvested for sale or nursed to an advanced size for personal use (stocking in a household pond), for food, or for sale. This has simple system proven highly effective and has been replicated on a large scale in the NW region of the country where sustained secondary adoption has followed dissemination of the techniques through farmers field school. Adopting farmers have adapted this

technique further, and often stock Indian and Chinese major carps into their systems for subsistence purposes. Adopters of this technology pursue livelihoods based on small-scale rice cultivation, with 68% falling into lower wealth groupings. The increased productivity that results from integration of fish into these farming systems generates increased protein consumption, food security and income flows, all of which are particularly important during the low income months prior to rice harvest. Outputs relating to decentralised seed production were monitored in the field by CARE Bangladesh, its technical officers and those of partner NGOs. Monitoring was also carried out through the AFGRP supported field research team worked in collaboration with CARE and the WorldFish Center. The scope and implementation of extension activities and their impacts are logged in several CARE and AFGRP/WorldFish Center reports. A PhD student from the Institute of Aquaculture, University of Stirling conducted extensive research into the impacts of project application and adoption. Participatory research techniques were used to investigate impacts across a representative sample of end users, of which half were categorised as extreme poor. Attention was given to the technology's implications for female and male livelihoods in low, moderate and high wealth groups, and to those for their dependents; both young and elderly. Primary and secondary adopters, non-adopters, late and early rejecters of the technology from ten communities were surveyed in order to comprehensively account for patterns of use, adaptation and failure. Analysis of the impacts of different dissemination pathways taken by CARE and its partners also allowed for the most successful and cost effective approaches to be identified. The validation process showed dramatic increases in fry and fingerling production at the regional level and significant increases in productivity at the farm level arising from the technology transfer that had occurred during the project. The long term sustainability of seed production in the absence of institutional support and its continued lateral transmission from farmer to farmer is robust evidence of end user validation.

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 output has been validated in the field in NW Bangladesh. The Greater Opportunities for Integrated Rice Fish project implemented between 2000 and 2005 as a collaboration between CARE Bangladesh and AFGRP built on previous successes with decentralised common carp fry production by distributing Nile tilapia brood fish to 2500 communities throughout NW Bangladesh. This region falls into the land water, and wetland rice based categories given above. Initial validation occurred through the observations of CARE and partner NGO staff during the course of promotion and support activities. A PhD Thesis also explored patterns of adoption and their implications in great detail. A recent follow-up study by the WorldFish Center tracked the adoption process following the withdrawal of institutional support. Results confirmed that adoption had taken place in every district and more than half the sub-districts in the region, with an average of six households in practicing culture techniques in each community sampled. Unfulfilled potential uptake in the region is estimated to be several times greater however. The moderate and extreme vulnerable poor in rural areas were the main beneficiaries. Women in these households and their young and elderly dependents were shown to be the main beneficiaries of the increases in household nutrition generated.

Current Situation

C. Current situation

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

Decentralised seed production for freshwater fish has been picked up well in Bangladesh. Improvements in productivity, income and protein intake have resulted for households producing fry for sale and those with access to water bodies in which to restock fingerlings for on-growing. Poorer households, often without access to water bodies to restock seed themselves, value the activity for cash generation relatively more than the better off who tend to restock and raise more for household subsistence. Furthermore, seed production efficiency is found to be greatest in smaller rice plots. Rice plot size is positively correlated with wealth, meaning that the poorest households obtain the greatest production efficiencies from the system. The technology is now relatively well established and self-sustaining as a result of informal farmer to farmer promotion and demand from pond farmers and seed traders. The multiplier effects of promoting tilapia seed production in rice-fields have also been demonstrated through improved availability of high quality seed to other farmers. In an associated trial the inclusion of Nile tilapia polycultures in seasonal ponds in NW Bangladesh increased the productivity of seasonal ponds by 36% at similar management levels. However, potential impacts both the NW and throughout the country could be multiplied by further development which increases broodstock availability and farmer access to marketing networks. There is also important evidence of the potential to extend these approaches in other areas of Bangladesh, more widely in the region, and in other regions.

*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).***

As indicated in Question 11, outputs are being used in village communities across Northwest Bangladesh. There is exceptional potential to expand application throughout the rest of Bangladesh by dissemination of technical seed production knowledge. In hilly regions of Northern Vietnam decentralised production of Nile tilapia and common carp seed in rice fields have also shown benefits to farmers. The species has proven popular with farmers who find it to improve system productivity when stocked in polycultures, and would otherwise find it difficult to access high quality seed produced in large lowland hatcheries. Given the simplicity and appropriateness of this of this approach to seed production it holds considerable promise for further adoption in numerous countries if promoted correctly

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

All forms of decentralised seed production, not only rice field based, have great potential since unfulfilled demand for cheap readily accessible high quality seed currently acts as one of the greatest barriers to the adoption of aquaculture, with seed constituting the major input cost in systems in many locations. In countries such as Thailand, where aquaculture has become established on a large scale and is widely geographically distributed, overcoming this constraint has been seen as one of the key facts of success. Potential in this regard exists not only with freshwater fish species but with marine fish such as groupers and shrimp and prawn. The exact scale of current rice based fish seed production in Northwest Bangladesh is not known. However, 194,840 households

received training in production techniques at farmer field schools. Given an overall average primary adoption rate of 10 to 20% and overall secondary adoption rates in the order of 60% of primary adoption, it can be assumed that approximately 30,000 households currently benefit from the transfer of this technology. Furthermore current adoption in the NW is estimated to be only 15% of that which could potentially be attained. If extended to all suitable locations throughout the country, and beyond, the final scale of usage could ultimately be huge. Farmer field school, the information dissemination vehicle used by CARE, ran for a period of 18 months at three month intervals coinciding with each of the four seasons, but the organic spread of knowledge in this region of the country may now facilitate more rapid establishment among secondary and tertiary adopters.

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).***

The integration of AFGRP research with the work of CARE and other NGOs was important for capacity strengthening. Involvement of NGO staff in trials and research provided them with first hand experience of the success of rice-fish seed production techniques and helped to develop personal understandings which assisted in the dissemination of this knowledge. NGOs especially the larger ones have provided a crucial platform for the promotion of decentralised seed production since their existing highly developed networks in Bangladesh allow promotion at the grass roots level to occur. In this instance they provided the best available vehicle for disseminating knowledge to large numbers of people. However, smaller NGOs tend to very strongly project driven due to reliance on external funding sources and lack the resources to initiate projects without the support of larger organisations, meaning that promotion is highly contingent upon funding availability. Some higher level endorsement for decentralised approaches can therefore be critical to any larger scale uptake as initial efforts to promote the practice over significant rural areas requires significant resources and effective public-private partnerships that build on established networks. This technology is most relevant to the poorest farmers and, arguably, those who have no history of practising aquaculture. Among richer groups and those already producing pond fish the relatively modest yields generated may fall short of expectations and act as a disincentive to continue further production. This in tern limits the possibility of further organic spread to other farmers. For smaller, poorer, operators however returns are sufficient to encourage sustained adoption. It is therefore import that NGOs involved in dissemination are selected on the basis of their ability to deliver this technology to marginal groups. Although the costs of this activity may initially be higher than targeting typical early adopters who may form a part of established networks, the ultimate degree of success and value for money achieved is likely to be far greater. Informal institutional structures and actors within them have also been critical to the sustained adoption of the output. Local capacity in this regard is increased by linkages between successful farmers and their neighbours and between farmers, fry traders and pond owners, all of which contribute to the spread of knowledge relating to seed production.

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).***

CARE and its partner NGOs have not continued the formal promotion of decentralised seed production in Bangladesh since their GO-IF project ended in 2005. However, informal farmer to farmer promotion is continuing to elicit adoption of the technology by further households.

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)****.*

A number of barriers currently hinder further adoption in NW Bangladesh. Poor access to tilapia brood fish in remoter areas currently hampers wider application. There are also potentially concerns over the long term genetic viability of fry from limited numbers of broodstock where adoption has already taken place. Also in remoter areas, there is evidence that limited penetration by fry traders inhibits the sale of fry and fingerlings. This may impact the extraction of maximum benefit by end users since, although household consumption (for restocking and food) is an important facet of fingerling production, the poorest end users prefer to sell seed of cash. Restricted distribution of seed also limits the multiplier effect gained from employment for seed traders and increased tilapia growout. Despite these issues the very simple nature of rice field seed production means that a well developed infrastructure is by no means a prerequisite to sustainable adoption. The most common reason for adopters to later abandon production results from changes in land tenure as land owners understand the relatively high returns of fingerling production and seek to alter the terms of tenure to their own benefit.

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).***

Further promotion in areas outside the NW has the potential to be highly effective, both because the efficacy and sustainability of the technique has been proven and because tilapia production is increasing rapidly throughout the country meaning that demand for seed is increasing. Within the NW region the full potential of the system has yet to be realised. However, a number of suitable promotional pathways already exist. These include the Local Government and Rural Development and Local Government and Engineering departments which already work by establishing and supporting small farmers' and water resource users groups and carry out extension activities with them. As already identified, the highly developed NGO sector also has the capacity to provide effective extension in many instances. Since this institutional platform for dissemination activities already exists all that is required is to introduce the simple rice field seed production concept through it. These institutions could address the issues outlined in Question 17, by strengthening market linkages to traders through collective action and implementing public private partnerships to extend the availability of high quality hatchery produced tilapia broodstock into remoter areas.

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).***

As indicated in the previous question, the structure through which to effectively introduce the idea of decentralised seed production throughout Bangladesh already exists. Building awareness among policy makers of the potential for decentralised seed approaches and their contribution to poverty-focused aquaculture development and engaging them in their promotion is therefore and important step to ensuring further widespread

adoption. The WorldFish Centre would be a suitable coordinator for this work. Care must also be taken to ensure that the most suitable recipients of seed production knowledge (i.e. the poorest farming households and those not already engaged in aquaculture) are targeted by NGOs and GOs if maximum poverty reduction impacts are to be achieved. Such an approach would also be applicable to Vietnam where organisations such as SUFA already have the target of benefiting the poor through development of aquaculture and the capacity to advance its promotion. In both instances it is critical to ensure that policy makers know that this output is useful in their context. Effective monitoring and feedback, such as that which informs this proforma, should also be central component of these efforts since it enables impacts to be measured and approaches to be adapted accordingly. Farmer field schools have proven highly effective in stimulating adoption of seed production. Field schools which focused on raising farmer awareness and understanding of rice field ecology were found most effective. A more ambitious farmer field school curriculum dealing with a range of subjects was found to be somewhat less as an extension tool. Validation has shown that whilst secondary adopters derive clear benefits from seed production these are less pronounced than for farmers who were trained directly. Expanding the size of farmer field school classes and limiting the scope of the curriculum would therefore potentially extend benefits by encouraging greater levels primary technology transfer.

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 the impact of decentralised seed production have been carried out by CARE Bangladesh and DFID Integrated; Rice Fish II Qualitative Project Impact Assessment (2001) and a PhD Thesis “Decentralised seed production strategies in Bangladesh: A new approach to developing quality seed supply for sustainable rural aquaculture and livelihoods”, expected publication date 2007. An informal follow up study was also conducted by staff from the WorldFish Centre earlier this year. Some key take home points of this work are summarised below

1. Promoting decentralised seed production and supply can benefit poor rural people inadequately served by conventional approaches.

2. Access to irrigated rice fields, even through sharecropping or leasing, provides opportunities for seed production by the poor but marketing of the seed locally has broader impacts on poorer people who gain as traders and other intermediaries.

3. Large-sized, high quality tilapia seed available at the critical time for rain-fed fish culture enhances the productivity and returns from seasonal fish culture.

4. Sufficient numbers of high quality brood fish available locally through promoters with capacity to support

poor households with no fish culture experience are critical to successful adoption.

5. Building awareness among policy makers of the potential for decentralised seed approaches and their contribution to poverty-focused aquaculture development is important.

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*

Human capital has been raised through farmer field school training. This has increased farmer knowledge and skills relating to fish culture and the improved management of rice fields. Women have been shown to take ownership of husbandry activities such as the observation of fish behaviour and water levels in paddy adjacent to homesteads, and productivity is maximised where women are able to participate in this way. Children also make important contributions by, for instance, collecting common carp eggs for stocking. The ability to give gifts of fish seed to relatives and neighbours is frequently referred to by farmers as an important benefit. This activity augments the social status of the gift giver and assists in the cohesion of communities, thereby raising social capital, and facilitates the adoption of fish culture for new end users. Those involved in the marketing of seed also benefit in this regard through the creation of social networks and reciprocal relationships between buyers and sellers. Elimination of pesticide use is necessary in rice plots where seed fish has grown. Consequent declines in rice yield have not been reported however, as the fish play a role in pest control. 80% of primary adopters reported that production of wild crops (e.g. indigenous fish species) increased as a result, amplifying natural capital. Physical capital is most obviously impacted in the form of increased production and ownership of fish. For farmers owning both ponds and rice paddy, fish production in the pond increased an average of 60% as a result of immediate access to large high quality fingerlings. Annual gains in financial assets resulting from the sale of fingerlings by poor, middle income and better off households are as follows; US$23, US$46 and US$55. Fingerling production efficiency is highest in poorer households, but consumption of these fish as food items is also highest in these households, meaning that their financial returns are lower those of other income groups. This equates to 4% contribution made by rice field fingerling production to the annual income in poor households and a 3% contribution in rich households. For households producing fingerlings for growout in their own ponds, the contribution of fish production to household income was 12%. This is twice that recorded for households raising fish in ponds who do not producing fingerlings themselves. Furthermore, income from seed and food fish sales in poor households was found to be extremely important in helping withstand seasonal vulnerability during low income periods in May-June and September-November. Benefits were derived by all household members in all adopting groups. Nutrients derived from fish are widely recognized important for growth and development in children and pregnant women. As indicated in 14, it can be assumed that approximately 30,000 households currently benefit from the transfer of this technology

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.

Direct environmental benefits as referred to above include reduced pesticide application in rice fields stocked with fish and associated increases in the biodiversity of these systems. Improved water use efficiency also results. More broadly, severe population pressure on finite arable land and water resources in Bangladesh necessitates innovative approaches to diversifying crop production and extending the productive potential of existing natural assets in a sustainable manner. This output clearly answers this need. A major shift has occurred in Bangladesh away from wild inland capture fisheries, which in many cases have surpassed their maximum sustainable yield and are in decline. Increased uptake of aquaculture on a large scale may have the potential to mitigate pressure on some wild fisheries.

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

There are no documented adverse environmental impacts to date and no reason to predict that these will become evident in future since the technology is extremely low input.

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)***

By increasing and diversifying the productivity derived from finite land and water resources rice field seed production increases the resilience of poor practitioners to environmental trends associated with climate change, population growth and natural occurrences (e.g. increasing water stress) and shocks (e.g. rice crop failure)