CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

IRRI's Upland Rice Research

Follow-up Review to the 6th IRRI External Program Management Review

JULY 2006

THIS DOCUMENT CONTAINS:

- Science Council Commentary
- IRRI's Response to the Final Report of the Upland Review
- Transmittal Letter and Report on the External Assessment on IRRI's Upland Rice Research

SCIENCE COUNCIL

CGIAR

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Science Council Commentary
to IRRI's Upland Rice Research Follow-up Review

April 2006

The Science Council discussed the IRRI's Upland Rice Research Follow-Up Review Report (March 2006) in its 5th meeting (April 10-12, 2006) and presents the following commentary. The SC thanks Drs Franz Heidhues (team-leader) and Benjavan Rerkasem for having prepared a very readable and concise report in a tight timeline. The SC had an opportunity to comment on an early draft of the report and finds that the final report has addressed some of the concerns, mainly those related to sources of information and references.

The Panel's conclusions are very clear - that IRRI should continue to invest in research on rice in the uplands in Asia because new rice technology in the pipeline for uplands can make a difference. Their reasons are four-fold: Firstly, there is an obligation for IRRI to address the uplands because large numbers of poor people reside in these areas and because of a commitment to the Millennium Development Goals to alleviate poverty. Secondly, recent progress in research, namely development of aerobic rice and progress in breeding for tolerance to biotic and abiotic stresses (drought in particular) significantly increase the probability of impact in the unfavorable uplands conditions. Thirdly, IRRI has accumulated a wealth of knowledge about the uplands in genetic resources, farming systems and socio-economics, which gives it a strong comparative advantage to work together with NARES for addressing the particularly difficult problems of the uplands. Fourthly, there is need for NARES and international agencies to invest in research and development in the remote uplands; a reduction in IRRI effort would be a disincentive for such local investment, a signal that may have already been perceived with the reduced investment by IRRI in the upland system.

Notwithstanding this report the SC view remains that IRRI could better use its resources that are currently allocated for the uplands in the rainfed lowlands to meet the CGIAR goals. The SC notes that previous research has for years promised forthcoming results in terms of impact in people's livelihoods in the uplands, but there has been little documented outcome and impact so far. Furthermore, because the uplands present a highly complex, ecologically fragile and ethnically and socio-culturally heterogeneous environment, as described by the Panel in detail, probabilities for success are very low. Also, as stated by the Panel, research investment per hectare needs to be higher. While the Panel sees these characteristics as a justification for IRRI's continued and possibly even increased investment in the uplands, the arguments are not sufficiently convincing. The report has not identified the plausible pathway out of poverty in a convincing way to change this view.

The Panel has provided examples of impact for instance in China where modern upland varieties are being used by local farmers. And whereas the Panel has highlighted the importance of new technology as a contributor to this impact, the SC notes the Panel's recognition that the drivers for the change were more likely related to policy (in the case of China – a policy for terracing and fertilizer use). These examples highlight the need to identify the pathway and the opportunities for agricultural research, and the role of policy or advocacy as the most appropriate intervention. Also development of marketing infrastructure (roads, rice storage and marketing outlets etc.), technologies for other more remunerative alternatives (fruits. trees, high value crops); and providing marketing arrangements for these products are likely to be more effective in addressing food security, poverty and environmental sustainability.

The authors have extensively reviewed the available evidence of emerging impact in the uplands from results of research investments. However, the analysis of relative benefits from investment in the most difficult upland environments versus in the more favorable valleys is not strong. In referring to IFPRI's work on internal rates of return to research and development in less favored areas, the Panel should have differentiated better between the most marginal areas and the rest of the uplands areas where there is a continuum towards relatively more favorable areas with flat lands, and better access to inputs. There are other examples given of successful research in unfavorable areas, without the distinction between agroecologies, which would be necessary for the proper interpretation of the evidence. The earlier work shows that agricultural research and development is a good investment for impacting poverty in general, but is less persuasive about differentials among agroecologies.

The Panel describes the work so far accomplished by IRRI in upland rice research in plant breeding, NRM and social science research. The Panel places a lot of emphasis on aerobic rice as a new technology that could make a difference in the uplands. It is the SC's understanding that upland rice is almost always grown aerobically like other crops and that earlier breeding programs to develop improved varieties for the uplands were breeding for "aerobic rice". Further, these breeding programs inter-crossed traditional upland varieties with high yielding *indica* from the irrigated programs. The SC also understands that what is new about aerobic rice is the targeting of these materials to traditional irrigated areas for a new system that will use water more efficiently. The report does not address the key question of why adoption rates following some 30 years of research have been so low in the uplands. The SC believes that the aerobic rice technology has its real potential in the lowlands through water saving, where it is truly a new technology. A question therefore remains of what the spillovers are from production of aerobic rice in lowlands/irrigated areas, and what will be the effects of lower prices from productivity gains there (at probably a faster rate?) on the future competitiveness of upland rice?

The Panel argues that the shift in IRRI's upland research paradigm (research on upland rice systems rather than on upland rice) and new technologies in the pipeline particularly in germplasm enhancement, are making success in the uplands considerably more likely than before. The Panel concludes that what is needed are improved seed and fertilizer. However, in the very environment this study was most concerned with, the main constraint is how to get such inputs to farmers (access and affordability), and get the communities linked with markets. The technology assumed now to lead to impact has been around for a while, and its adoption and the replicability of innovations and improvements have been the problem. As the Panel states, the spillover from technology improvement to the poorest and most difficult areas often doesn't take place. Rather than more farming systems research, the SC believes that policy research might be more appropriate.

The Panel considers IRRI's involvement in the Consortium for Unfavorable Rice Environments (CURE) necessary for mobilization of funds, building capacity and enhancing partnerships for disseminating knowledge about rice. The SC endorses the Consortium as an effective means of dealing with the highly heterogeneous upland research domains. The SC suggests that the responsibility for developing crop husbandry practices suited to location-specific conditions is better fulfilled by agronomists in the NARS. The proposed position of an agronomist at IRRI is not justified, as it is not likely to add substantial value to IPG research.

The last two decades have seen a lot of work "identifying constraints and opportunities for the research outputs to have impact on local livelihood in uplands" (pg. 17 of the report). Thus there is little that an economist, as proposed in the Review, can do to further the understanding of upland cropping and farming systems, again as IPG research. The SC believes that the social science and policy research that would address local questions is best done in the national programs.

The NARS in the Consortium do need access to the IPG of the IRRI research in terms of improved pre-breeding materials for aerobic rice (a spill out from the strategic aerobic program), drought tolerance, phosphorus uptake (provided that the enhanced uptake is sustainable), and methods for screening for weed tolerance, drought and more durable resistance to blast, nematodes etc. These materials can be adapted by the NARS for use in their local programs. Thus in the view of the SC, IRRI's role should be in facilitation and advocacy and hopefully CURE can be supported by all partners to offer the framework for such collaboration. What is needed is an analysis of how CURE differs from the earlier uplands consortium (formed in 1994) and what is needed to make such a consortium sustainable after the project period.

The SC believes that there remains a pressing need for IRRI to follow the recommendation of the 6th EPMR to "include the results of *ex ante* impact studies in unfavorable environments in its priority setting exercises. The existing evidence indicates that less emphasis should be placed on uplands with low production potential and more emphasis is needed on rice-based cropping systems along the toposequence and favorable non-flooded rice systems."

The Center needs to understand the plausible pathway for impact in the rainfed systems – uplands and rainfed lowlands – to decide where the obstacles can be addressed by rice based systems science and focus the emerging research innovations for increasing productivity, and ultimately alleviating poverty. Neither the fact that research is on-going nor an assumption that the research pipeline is now full sufficiently justify keeping this research going from a strategic point of view.

If IRRI continues with upland rice research, as now planned, the SC strongly urges that IRRI set itself very clear targets in monitoring progress in outputs and outcomes. The Center should be prepared to provide sound evidence of this monitoring and progress towards outcomes in the uplands for its next EPMR.

IRRI's Response to the Final Report of the Upland Review

IRRI would like to thank the Science Council for commissioning this External Review of its work on uplands. IRRI's research on uplands continues to generate a lot of debate, with questions often being raised about the potential for impact and IRRI's comparative advantage. A critical assessment of these issues was therefore very timely, because of the continuing debate and because IRRI is in the process of formulating its new strategic plan to guide its future research.

We would like to express our appreciation to the Review Team for its comprehensive analysis and for providing unambiguous recommendations. We concur with the review findings that IRRI's research on uplands has made substantial progress and generated several technologies with a potentially high impact. As mentioned in the report, IRRI's research is indeed at a "turning point" (page 16) and a substantial impact is likely to result from the technologies that are currently available and those that are in the pipeline. We also appreciate the finding of the review that IRRI's comparative advantage in upland research arises from its excellence in rice science, and its strong partnership with NARES in facilitating the exchange of information and technologies through regional consortia. Similarly, the review report has commended a "paradigm shift" in IRRI's research from "upland rice" to "rice in uplands" that is reflected in its attempt to address upland research from the perspective of rice landscape management.

We accept the recommendation for IRRI to stay involved in upland research. The high incidence of poverty, widespread food insecurity, and environmental degradation are the main reasons why IRRI has continued to invest in uplands. In the context of achieving the Millennium Development Goals of the United Nations, IRRI's efforts to improve the productivity of rice-based systems in uplands are certainly important. By using the rice landscape management perspective, we hope to make a substantial impact on poverty reduction and environmental protection in these fragile uplands.

We accept the advice that IRRI should maintain "a credible allocation of core resources to its upland rice program." We agree that without such an allocation of core resources, IRRI's ability to mobilize external funding will be impaired. However, a shrinking core resource base under the current funding scenario forces hard choices. IRRI will give due consideration to this advice in making its resource allocation decisions.

We agree with the Review recommendation that a minimum commitment of three scientist equivalent times should be made for uplands. Resources from a combination of core and restricted projects will be used to meet this minimum requirement. We will also actively seek to augment the scientific inputs by engaging skilled research staff from NARES and through secondment of scientists from advanced research institutes.

UNIVERSITÄT HOHENHEIM

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Dr. Ruben Echeverria
Science Council Secretariat
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Dear Dr. Echeverria,

Herewith we submit to you the report of the External Assessment of IRRI's Upland Rice Activities in Asia conducted by Dr. Franz Heidhues, University of Hohenheim, Germany, and Dr. Benjavan Rerkasem of Chiang Mai University , Thailand. The assessment was carried out following the ToR, as given to the review team; they are attached as Annex I of this report.

We visited IRRI headquarters on December 12 to 14, 2005, where we had discussions with IRRI's management and staff and met representatives of the NARES of India, Indonesia, Nepal and the Philippines. The mission continued to visit the VAAS in Hanoi, Vietnam, where it also held discussions with the representative of TUAF on December 15, 2005, and subsequently the LIRR-TP in Vientiane, and the NAFREC and IUARP in Luang Prabang, Laos from December 16 to 18, 2005, as well as some of their field work activities.

The team reviewed the uplands rice situation in key rice producing countries of Asia where IRRI is actively involved in uplands rice research, assessed achievements in the past, studied driving forces of the development of rice-based upland farming systems in their development and formulated its recommendations for IRRI's role in future rice research for the uplands taking into account the capacities and potential future contributions of NARES.

We are convinced that research for rice based systems in the uplands will remain relevant for the foreseeable future and that IRRI has an important role to play in uplands rice research. To fulfil that function the report recommends that IRRI's resource allocation to uplands rice research should be maintained at a level that allows it to fulfil that mandate and that at the same time is sufficient to convey to bi- and multilateral donors and other stakeholders credibility.

The team is thankful to IRRI's management and staff, to the representatives and staff of NARES and the research stations visited and all other experts contacted for their support, information and cooperation provided as wanted.

Sincerely yours,

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IRRI's Upland Rice Research External Assessment

by

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Acronyms

ADB	Asian Development Bank
CG	Consultative Group
CGIAR	Consultative Group on International Agricultural Research
CIAT	International Center for Tropical Agriculture
CIRAD	French Agricultural Research Center for International Development
CURE	Center of the Consortium for Unfavorable Rice Environments
EMBRAPA	Brazilian Agricultural Research Corporation
EMPR	External Program and Management Review of IRRI
EU	European Union
ExCO	Executive Committee
GDP	Gross Domestic Product
ICRAF	International Center for Research in Agroforestry
IFAD	International Fund for Agricultural Development
INGER	International Network for the Genetic Evaluation of Rice
IRD	Institut de recherche pour le développement
IRRI	International Rice Research Institute
IUARP	Integrated Upland Agricultural Research Project
IWMI	International Water Management Institute
JICA	Japan International Cooperation Agency
MAS	Marker Assisted Selection
MDG	Millennium Development Goal
NAFRI	National Agriculture and Forestry Research Institute
NAFReC	Northern Agricultural and Forestry Research Center
NARES	National Agricultural Research and Extension System(s)
NGO	Non-Governmental Organization
NOMAFSI	Northern Mountainous Agriculture and Forestry Science Institute
PDR	People's Democratic Republic
PVS	Participatory Variety Selection
R&D	Research and Development
SAM	Mountain Agrarian Systems Program
SC	Science Council
SFB	Special Research Program
VASI	Vietnam Agricultural Science Institute
VND	Vietnam Dong
WARDA	Africa Rice Center
YAAS	Yunnan Academy of Agricultural Sciences

Summary

This external assessment of IRRI's Upland rice research was carried out on request of the SC according to Terms of Reference attached as Annex I. The request stemmed from disagreement among CGIAR donors on how much IRRI's research investments in marginal areas yield in terms of productivity increase, sustainable impacts on livelihood improvement, poverty reduction, food security and environmental sustainability. In conducting this study on IRRI's upland rice research the team reviewed the relevant documentation provided by the SC-Secretariat, IRRI, NARES and other stakeholders. It visited institutions and research stations in the Philippines, Vietnam, Laos and Thailand from the 4-21 December 2005 and had discussions with experts and representatives of the NARES of India, Indonesia, Nepal and the Philippines.

The uplands are of key importance worldwide. They account for a substantial part of the agricultural land and a major share of often extreme poverty; they are an important storage of water and energy and a rich source of biodiversity. At the same time they are highly complex, ecologically fragile, ethnically and socio-culturally extremely heterogeneous, economically disadvantaged and often politically and institutionally marginalized. Typically, upland areas are remote and poorly connected to communication systems. They lack basic infrastructure, and thus have no or limited access to markets, inputs and essential agricultural support services, such as agricultural extension and credit.

In the uplands of Asia rice plays an important and in some regions a dominant role in crop production. It is a key crop in agricultural land use, and increasing rice yields are a determining factor in reducing the encroachment of agricultural land into forest areas. It is the staple food for the population and the base for food security of particularly the poor.

The uplands in many countries of Asia are under intense and rapidly rising pressures. High population growth, resettlement programs and migration tend to set in motion spiralling processes of natural resource degradation, characterized by shortened fallow periods, declining soil fertility and increasing soil erosion and environmental degradation. As a consequence, agricultural productivity decreases leading to further encroachment into forest areas and increasing cultivation of marginal lands. These processes often take place with self-accelerating speed and result in rising poverty, unemployment and food insecurity, particularly in regions that are ecologically, economically and socio-culturally heterogeneous and where complex interrelations between causes, determining factors and effects dominate.

Given these characteristics the uplands pose a particular challenge to agricultural research in its efforts to increase productivity, conserve the environment and reduce poverty and food insecurity.

- First, rather than focusing on single component interventions an integrated approach seeing rice as an interlinked component of the farming and landscape management system is needed. Research on improvement in uplands rice needs to be integrated with farming system analysis and environment conservation research. IRRI's move from 'uplands rice' to 'rice in the uplands' is rightly following this approach.

- Second, without making use of local knowledge, innovation generation and adoption by farmers are likely to fail. IRRI is to be commended for widely integrating farmer's knowledge and local stakeholders' preferences in its research approaches, notably in the participatory variety selection (PVS) processes.

- Third innovations/improvements under these circumstances typically are location-specific and not easily replicable. Thus, upscaling will be more difficult and outreach will be slower than in more homogenous areas and is likely to require a substantial amount of accompanying adaptive research and support. As a result, research investments per ha tend to be higher for uplands as compared to lowland production.

The controversy about how much to invest in upland rice research stems from the disappointing outcomes and impacts of past upland rice research, compared with the irrigated and lowland rainfed rice systems. While evidence of significant increases in farm yields in the past through improved upland rice varieties is still limited, there are now new improved materials that have been tested to yield 3-4 tons/ha (with fertilizer) compared with 1.5-2 tons/ha for traditional check varieties; they are just beginning to reach farmers. The new upland rice varieties are indica type selected in non-flooded, aerated soil. They have been shown to out-perform tropical japonica varieties in favorable upland environments as well as on infertile, acid soils; they are superior to traditional varieties with improved lodging resistance, a higher harvest index and better input responsiveness. IRRI in collaboration with NARES has built up an impressive body of knowledge on this new upland or aerobic rice, which has laid the foundation for new innovations that should benefit breeding programs targeting water-saving efforts in irrigated rice and rainfed lowlands as well as those for the uplands.

To overcome major constraints of the uplands, the IRRI upland rice program has covered the whole spectrum from pre-breeding understanding, identification of genetic control of tolerance, better adaptation to specific stresses to identifying, locating and mapping of relevant genes for deployment. It has also developed appropriate methodologies from marker assisted selection (MAS) to participatory variety selection (PVS) and transfer to national programs. PVS has been helpful in integrating farmers' preferences concerning grain types and relevant traits and genes into breeding programs. Also, socio-economic research at IRRI focusing on understanding rural livelihood systems in the uplands, their determining socio-cultural, institutional and economic constraints and their relevance for technology adoption has enormously contributed to raising the chances of higher adoption rates. Several traits and genes that are likely to confer the ability to overcome important stresses in the uplands are ready, others nearly ready for deployment in breeding programs:

- Genetic improvement for drought tolerance focuses on both moderate stress at flowering and severe drought stress. The physiological basis for this improved tolerance is being studied concurrently with mapping efforts. Genes for drought tolerance have been identified and are expected to be deployed in breeding programs in three years.

- Much improvement in blast resistance, in both defense against many races of the pathogen as well as durability of the resistance over time, is expected from the understanding that the efficacy of blast resistance is increased when genes for partial resistance are combined together in a single rice genotype. This strategy has already been incorporated into the breeding program.

- Also being incorporated into new upland varieties being bred at IRRI is the gene Pup 1, which increases the ability of rice roots to take up soil phosphorus.

- The ability to germinate and establish well in anaerobic conditions has been identified as an important trait for good establishment in areas where upland rice is grown on heavy soils on flat land, especially in eastern India, Indonesia and the Philippines. This trait has been identified in several traditional varieties and is now being mapped; it is expected to be available for incorporation into breeding programs in 2-3 years.

- Biotic stresses due to weeds, root aphids and nematodes build up rapidly under continuous cropping of upland rice, especially on light textured soils, so threatening sustainability of intensive upland rice systems. Tolerance to these biotic stresses has been identified in traditional and other varieties. The physiological basis and genetic control of tolerance are being studied with a view to deploy the traits in breeding programs.

All evidence suggests that IRRI's upland rice research is at a stage where it can make important and rising contributions to increasing rice productivity in the uplands. IRRI's rice research for the uplands can provide substantial research outputs for understanding the uplands and the role of rice in it, raising rice yields substantially and developing improved germplasm with traits and genes for meeting specific requirements of the uplands. In this way IRRI can substantially contribute to production growth, food security and poverty reduction in the uplands.

Investing resources in uplands rice research has to be seen in relation to using those resources for research in more favorable areas. The enormous contribution of increased rice productivity to improved livelihood, poverty reduction and economic growth has been largely based on research results for more favorable areas. Increased rice productivity has raised farmers' income and provided new employment and income opportunities including for the landless rural poor. It has led to lowering rice prices for the urban and rural consumers and thus contributed significantly to poverty reduction. And it has released the food constraint and thus allowed countries to focus on accelerated growth and employment in non-agricultural sectors. These have proven to be most important pathways out of poverty and their proper functioning will remain vital also in the future.

At the same time, the emphasis on favorable environments in research is bypassing large parts of the uplands, that is major poverty areas, particularly those that are remote, not linked to infrastructure and communication systems and thus not integrated into markets and not reached by agricultural service institutions, such as extension, credit and modern input supply. While some remote areas with expanding infrastructure are getting more and more connected to the favorable regions, there remain substantial areas in the mountainous regions, where extreme remoteness still exists and is unlikely to be overcome for considerable time. The spill-over effects from the more favorable areas to the difficult uplands are unlikely to work for these regions, where roads either do not exist or cannot be used over extended periods of the year, raising travel time to the next market center up to several days. Moreover, there is substantial evidence that in areas populated by ethnic minorities ethnic barriers, language and lack of education prevent people to migrate. If rice research is to benefit also these poorest groups, it has to work on rice in these difficult environments. There is also rising evidence based on IFPRI research that rates of return on research investments in more favored areas, contrary to past experience, may not be as high in the future as they were then, and that investments in lower potential areas have higher rates of return, both for agricultural growth and poverty reduction. Finally, in raising productivity in the more favorable lands of the upland areas upland rice research can help to release the pressure on the most fragile lands and free them for reforestation and resource conservation activities.

Thus, investments n uplands rice research are to be recommended for their high potential in promoting production growth, reducing poverty and supporting environmental conservation.

IRRI has a vital role to play in uplands rice research; it is doubtful that NARES by themselves could exploit the full potential of uplands rice research. IRRI's important role as a pool of knowledge about rice in the uplands, its leadership in regional networks, notably CURE, and its highly valued training and capacity building function in and for NARES call for a continued significant engagement in uplands rice research.

Conclusion and Recommendations

In this study team's view, taken together these are important reasons for IRRI to follow a dual strategy, to stay involved in the favored areas rice research and, at the same time, to continue its upland rice research for the more difficult environments. It needs to find the proper balance between the two.

- To be able to achieve the potentials of upland rice research discussed above at any significant level the study team would recommend a minimum of technical inputs from a team of 3 scientist-equivalents: one breeder; one agronomist with experience in ecology and cropping systems and participatory research competence; and one economist with social science background. Cross disciplinary interactions and experience in all three would be essential to raise farmers' upland rice yield as it requires essentially the combination of improved upland rice varieties that are acceptable to local tastes as well as tolerant to local biotic and abiotic stresses and the application of fertilizer, better agronomic practices and integrating improved rice varieties into the farm household's set of preferences and practices. Also natural resource and landscape management issues need to be taken into account.

- The team members would also carry out an important function in capacity building in NARES. Modest additional resources made available for in depth, good quality rice science, conducted by local scientists within the framework of the upland rice consortium and directed at the uplands would go a long way towards building up local capacity that brings together basic understanding of rice in one of its most difficult environments with local insights, as well as contributing to solutions for upland problems. Also outside Asia there is a substantial experience in uplands rice research accumulated, for example, in Latin America, particularly in EMBRAPA in Brazil. IRRI should make full use of that knowledge by building close partnerships with those institutions.

- Where the upland research is best located is a question that the study team found difficult to address. Certainly close interaction with IRRI's other programs would be essential, particularly for the breeding work. On the other hand, being close to uplands environment would be beneficial particularly for the work on ecology and cropping/farming systems. In deciding the location question, also the amount of time and resources spent on traveling would be an important consideration.

1. INTRODUCTION

The sixth External Program and Management Review of IRRI (6th EMPR) was carried out by a panel chaired by Dr. Richard Flavell between September 2003 and April 2004. In its third (of ten) recommendation the Panel recommends *"that IRRI includes the results of ex ante impact studies in unfavorable environments in its priority setting exercises. The existing evidence indicates that less emphasis should be placed on uplands with low production potential and more emphasis is needed on rice-based cropping systems along the toposequence and favorable non-flooded rice systems"* (CGIAR 2005, p.XIII of 6th EMPR-report).

Following the recommendations of earlier EMPRs, IRRI had, from 1998 to 2003, reduced its budget for the upland program from US$ 2.6M, representing 37% of the total allocation to unfavorable environments to US$ 0,83M, representing only about 8% of the total budget for its Program 3. Given IRRI's by then small investment in the uplands area, the SC in its review of the 6th EMPR, Recommendation 3, concluded that "*the small amount spent on upland rice would be better spend on lowland rainfed rice systems.*" Subsequently, the ExCo did not agree with the SC-conclusion and suggested IRRI to "*continue to work on upland rice in coordination with WARDA.*" In the height of this discussion the CGIAR "*requested the SC to establish an independent panel to study the situation of upland rice in Asia and IRRI's potential contribution of NARES or other parts of the CGIAR system.*" (CGIAR 2004: 15). This study was carried out in response to this CGIAR request to the SC.

In conducting this study on IRRI's upland rice research the team reviewed the relevant documentation provided by the SC, IRRI, NARES and other stakeholders. It visited institutions and research stations in the Philippines, Vietnam, Laos and Thailand from the 4-21 December, 2005, and had discussions with experts and representatives of the NARES of India, Indonesia, Nepal and the Philippines. A detailed itinerary of the consultations is presented in Annex II.

In accordance with its Terms of References (attached as Annex I) the team reviewed IRRI's past involvement in rice research in the uplands, covering the relevant areas of research, and assessed outputs, outcomes and impacts from that research. The team examined the role of and comparative advantage of IRRI as rice based research center in uplands rice research. This study report includes a recommendation on whether IRRI should continue research on rice systems in the less-favored uplands and the necessary minimum involvement with regard to the needed critical mass to have impact.

The team would like to thank the secretariat of the SC, IRRI's management and staff, the representatives and staff of NARES and the research stations visited and all other experts contacted for their support and the information and cooperation provided. It extends its particular appreciation to Dr. Judith Moellers for her valuable contribution to this study.

2. THE UPLANDS: RELEVANCE, CHANGE PROCESSES AND DRIVING FORCESThe Relevance of the Uplands and Uplands Rice

The uplands worldwide account for an important part of agricultural land and a major share of rural poverty. These regions are of basic importance for around 10% of the world population that directly depends on the resources of these regions and for the global ecological system. They are important storage of fresh water and energy, and offer living space for plants and animals, which are often found only in these regions. The mountainous regions distinguish themselves from other regions by complex ecological interactions and high vulnerability. The heterogeneity of climate, edaphic, hydrological, economic and socio-cultural conditions bring about a high variability of land use and production processes.

In south-east Asia uplands make up about 50M hectares of land with over 100M people dependent upon them (Pandey and Khiem 2002). The area under uplands rice is reported to be 9M ha; south Asia accounts for about 60%; the remainder being in south-east Asia. As upland rice is mostly grown in rotation with other crops, the actual area under upland rice based systems is much larger. Assuming a 3-year rotation, Pandey estimates the area under upland rice based systems in Asia to be about 15M ha (Pandey, Presentation to study team, December 2005). The upland rice area in Asian countries ranges from 2% of the total rice area in Thailand and China to 11%-12% in Indonesia and India up to 36% in Lao PDR (Huke and Huke 1997). Worldwide 14M ha are counted as upland rice land accounting for 11% of the world rice area. Given its lower yield level upland rice contributes substantially less to total rice output in relation to its share in total area. Nevertheless, in some regions upland rice plays a dominant role in crop production, accounting, for example, for 46% of the net value of crop production in the northern uplands of Vietnam (Minot et al. 2006).

Among the rural population the uplands account for a major share of the poor and food-insecure people. Thus, the incidence of poverty in the uplands is given as 52% in Laos, 59% in Vietnam, 68% in Nepal and 45% in Northern India; these poverty rates by far exceed the national average in the respective countries. Also, poverty in the uplands often is extremely severe; seasonal and chronic food insecurity and malnutrition are widespread (Minot et al. 2003, Pandey et al. 2005).

Rice shortage and poverty are often highly correlated in upland areas that have poor access to markets (ADB 2001). In remote regions of the uplands in countries as Laos, Nepal, India and Vietnam, rice production is insufficient to meet local consumption needs. In northern Vietnam, for example, the rice requirements of almost one third of the households exceed local production (Pandey and Khiem 2001), despite the fact that Vietnam is now a major rice exporting country.

2.2 Change Processes in the Uplands

High population growth, resettlement programs and migration have increased the pressure on the fragile natural resources in many marginal mountainous areas in Asia. Often these pressures on scarce resources initiate self-propelling degradation processes, so called vicious cycles. The vicious cycle of natural resource degradation that is typical for upland areas under pressure is characterized by shortened fallow periods, declining soil fertility and increasing soil erosion and environmental degradation (Figure 1). As a consequence, agricultural productivity decreases leading to further encroachment into forest areas and increasing cultivation of marginal lands. These processes often take place with self-accelerating speed and result in rising poverty, unemployment and food insecurity, particularly in regions that are ecologically, economically and socio-culturally heterogeneous and where complex interrelations between determining factors, causes and effects dominate (SFB University of Hohenheim 2006).

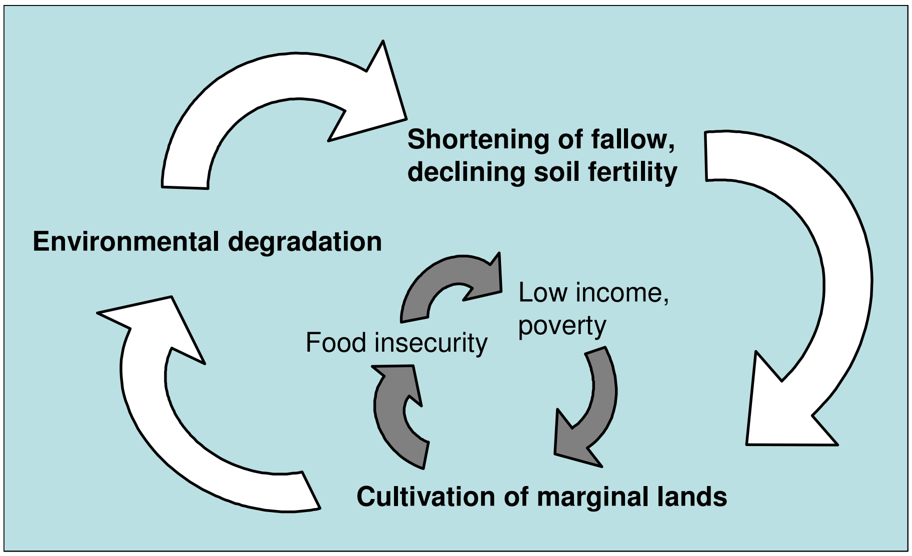

Figure 1 The vicious cycle of natural resources degradation in the uplands of Asia

Moreover, ethnic diversity adds to the complexity of the uplands. The mountainous regions of Asia are mainly inhabited by ethnic minorities which often are politically, economically and socially marginalized. Traditionally the minorities living in mountainous regions practiced shifting cultivation. With increasing population density they were forced to intensify agricultural production, setting in motion vicious cycles discussed above.

Within the uplands one needs to distinguish between the relatively flat valley bottoms and the more or less steeply sloped uplands. The more sloped uplands typically are remote, lack basic infrastructure, and thus have no or limited access to inputs, markets and essential agricultural support services, such as agricultural extension and credit. While some road and electricity connections open up areas and provide opportunities for change, large areas remain isolated; villages in these areas often can only be accessed walking, notably during the rainy season, requiring several hours to several days to reach. For these areas farm households' own upland rice cultivation remains the base for their food security. They grow their crops including rice mainly for subsistence using their own labor and few other inputs, and rarely fertilizer. Consequently, rice yields are low, often not exceeding 1.0-1.5 t/ha.

In these areas gross margins for upland rice are relatively low and render it non-competitive with most other crops. Gross margins of upland rice in the Son La Region of Vietnam averaged 2.6M VND/ha as compared to paddy rice with 7.0M VND/ha. Also other crops like soy beans with 5.8M VND/ha and cassava with 3.0 VND/ha out-competed upland rice

(Dufhues 1999). As a result of upland rice' low productivity, and in some countries reinforced by government policies discouraging upland rice, the upland rice area has decreased in regions where market access improved. Thus, the upland rice area has been declining in many countries in Asia during the last two decades, most markedly in the Philippines, Thailand and Vietnam. These developments and the large gap in gross margins seem to indicate that the future of upland rice is limited, even if yields of upland rice can be raised. However, it must be emphasized that for a considerable amount of time to come a large number of farmers in the uplands of Asia, particularly the poorest groups, will remain dependent on upland rice in sloped areas. Moreover, even farm-households that can diversify their income sources and integrate new production lines into their farming activities continue to grow rice as an important component of their farming system, providing the staple for the household's food security.

Relative gross margins indicate that it would be economically more attractive to focus productivity improvement efforts on rice cultivation in the valley bottom systems where yields and gross margins are higher than in the sloped uplands. This is a viable option for farmers that own lands in the valley bottoms or have access to valley bottom markets. For upland areas with increasing links to infrastructure and markets commercial crops, niche products (such as mulberry pulps, herbs, flowers, etc.), and off-farm employment offer new and diversified income opportunities. However, in some areas up to 70% of farmers do not own lowland fields; for them the increase in upland rice productivity on sloped terrain is essential, all the more so as road links between valley bottoms and mountain villages are rare. Also social barriers such as different ethnic groups and language hamper closer interaction and migration (Minot et al. 2006).

2.3 Uplands Complexity and its Implications for Rice Research

The uplands are known for their climatic, ecological, economic and socio-cultural heterogeneity and complexity. Upland rice is grown under climatic conditions varying from humid to sub-humid, on soils ranging from very fertile to highly infertile, in flat fields to steeply sloping areas. Farmers practice slash and burn with varying fallow periods to permanent cultivation. Also market integration, access to institutional services and policy outreach differ widely. For generating productivity increasing innovations for these regions three consequences follow:

- First, rather than focusing on single component interventions, an integrated approach seeing rice as an interlinked component of the farming and landscape management system is needed (Fan and Hazell 1999). Within the farming system improved productivity of rice is linked to the pressure on sloped uplands and thus to environmental protection, as discussed below. Research on improvement in upland rice needs to be integrated with farming system analysis and environment conservation research. IRRI's move from 'upland rice' to 'rice in the uplands' is rightly following this approach.

- Second, without making use of local knowledge, innovation generation and adoption by farmers are likely to fail. IRRI is to be commended for widely integrating farmer's knowledge and local stakeholders' preferences in its participatory variety selection (PVS) processes.

- Third, innovations/improvements under these circumstances typically are location-specific and not easily replicable. Thus, upscaling will be more difficult and outreach will be slower than in more homogenous areas and is likely to require a substantial amount of accompanying adaptive research and support. As a result, investments in research tend to be higher and progress in achieving impact may be slower (von Braun et al. 2005).

Productivity increase in uplands rice has been observed to benefit environmental protection. If households' food security can be achieved with less land, farmers in remote areas can be motivated to return the least suitable, highly sloped land to reforestation, though this may require special support. For the market linked areas, rice land – depending on the relative profitability and market access – may be switched to higher value crops; the most marginal lands can be released for reforestation. Pandey et al. (2004) report that intensification of upland rice areas in the lower slopes and terraces in southern Yunnan facilitated the conversion of steeper slopes, where upland rice used to be grown, into forested areas. To encourage farmers to reforest marginal sloped areas taken out of agricultural production it may be necessary to provide incentives. For example Vietnam has instituted a reforestation support program in the form of Decree 327 "Regreening of the Barren Hills" in 1993 and the "5M Hectar Program" in 1998 (Neef et al. 2006).

Also within the framework of the Millennium Development Goals (MDG) discussion, rice research for upland areas is relevant. As discussed above, upland rice is a key crop in farming systems in remote areas where the most severe poverty is being found. Research for upland areas is essential for addressing food security and poverty in these upland regions for at least a considerable time to come. It has also the potential for attacking deforestation and reducing slash and burn cultivation. Thus, upland rice research can make important contributions to the MDGs No. 1 poverty reduction, No. 7 environmental sustainability, and others directly linked to these, such as No. 2 primary education.

In its contribution to poverty reduction, apart from its impact on poverty incidence also its impact on depth of poverty is to be taken into account. Depth of poverty is particularly high in the mountainous areas. Thus, in Vietnam the mountainous north-west region shows the lowest GDP per capita (one third of the national average), has the lowest Human Development Index and the lowest literacy rate (ADB 2002). Also case studies of ethnic minority villages, carried out by the Environment and Social Safeguard Division of the ADB, describe extreme poverty situations in mountainous villages. Otsuka's village based study on the role of agricultural research in poverty reduction found per capita income in the unflavored rainfed village in mountainous environment to be less than half of what is shown for the rainfed favored village location (Otsuka 2000). Research in villages of the mountainous areas of Son La Province in Vietnam confirms the much more severe poverty situation in the remote mountainous villages as compared to those in the valley bottoms (SFB University of Hohenheim 2006). In pursuing rice research for the less favored areas, research has the potential to reduce particularly the severity of poverty. This may not be reflected in the head count numbers measuring poverty impact, the generally used measure of poverty reduction, as lifting people from extreme poverty to a level still below the poverty line would not affect the poverty incidence measure.

3. ASSESSMENT OF OUTPUTS, OUTCOMES AND IMPACTS

IRRI's upland rice research has been questioned on the basis of its low impact on overall rice production increase and its marginal effect on rice yield growth (6th EMPR, CGIAR 1993). Evidence available so far of significant increases in farm yields through adoption of improved upland rice varieties is still limited, partly because of the difficulty in disaggregating upland rice from the general statistics and partly because the newest improved materials are only just beginning to reach farmers.

Recently, however, progress was recorded in Indonesia, on a smaller scale in southern Philippines, and documented in on-farm trials in Lao PDR and eastern India. Yield gains in Yunnan province of China also benefited from IRRI-sponsored germplasm exchange through INGER. In this section we will first submit evidence of the relative importance of agricultural (including rice) research versus other investments in rural areas, of recent gains in upland rice breeding and then discuss constraints and specific research needs and assess outputs and outcomes from IRRI's upland rice program, highlighting those that have contributed in particular to the gains and are expected to do so in the future.

3.1 Investments in Agricultural and Rice Research versus Other Rural Investments

Governments in developing countries have been under severe pressure to cut public expenditures. Moreover, since the mid 1980s many governments and donors have given lower priority to agriculture, and it seems not likely that public investment in rural areas will increase substantially. Thus, efficient use of scarce public resources and their proper targeting to achieve both, economic growth and poverty reduction is of prime importance.

There have been many studies to assess the impact of different types of public investment on economic growth and poverty reduction. This is methodologically a difficult terrain as numerous factors and interlinkages between them, multiple pathways and location specific environments are to be taken into account. IFPRI has carried out a number of studies in recent years of public investment impact on agricultural growth and poverty reduction, heavily drawing on data and experiences from south and southeast Asia.

Fan summarizes key findings and states that "returns to public investments vary drastically across different types of investment and regions even within the same country" (Fan 2003: 8), implying a substantial potential for an increased growth and poverty reduction impact by a more effective investment allocation. He also finds that all studies conclude that agricultural research, education and rural infrastructure are the three most effective public spending items, and that "the trade-off between agricultural growth and poverty reduction is generally small among different types of investments and between regions" (Fan 2003: 9). IFPRI's research specifically on India has shown that investments in research and innovation development have the highest impact on agricultural growth with rates of return for research and extension as high as over 60% and 50%, respectively; similarly for poverty reduction they have potent effects, second only to investments in rural roads (IFPRI 2005).

A recent IFPRI study in the northern uplands of Vietnam yielded similar results. In applying three different methods, i.e. an analysis of two Vietnam living standard surveys, an econometric study of agricultural statistics and an assessment of farmers' perceptions, the study found that uniformly over all three approaches used yield growth turned out to be the most important factor in the expansion of rice production in the northern uplands of Vietnam. It concluded that agricultural research aimed at improving yields has been and is likely to remain in the short and medium term the cornerstone of rural income growth (Minot et al. 2006).

Given the evidence of these studies it is reasonably safe to assume that investments in agricultural research among the investment alternatives in rural areas are of highest, and perhaps the highest priority. They need to be accompanied and complemented, however, by investments in infrastructure and education to deploy their full potential for achieving the twin goals of poverty reduction and growth.

Focusing on the less favored areas regional studies of India and China suggest "that more investments in many less developed areas not only offer the largest poverty reduction per unit of spending, but also lead to the highest economic returns" (Fan 2003: 9). The studies also come to the conclusion, that while investments in irrigation played an important role in the past, they tend to have today smaller marginal returns in growth and poverty reduction. Thus, across regions, the return to investment in the less favored (rainfed) regions of western and southern India are now higher than in the irrigated lands of the northwest. By implication this means that investments in the less favored areas show a win-win potential in terms of both higher returns (efficiency) and equity (IFPRI 2005).

3.2 Genetic Improvement

From Simao Prefecture of China's Yunnan Province there is well documented evidence of steady yield increases in upland rice in three counties since 1995. The yield gains have been attributed to improved upland rice varieties developed by the Yunnan Academy of Agricultural Science (YAAS), which has in turn benefited from IRRI germplasm, including a variety released in 2000 as Luyin 46 which is an improved indica genotype B6144F-MR-6-0-0 developed in Indonesia. Also contributing to this productivity gain are an increased use of inputs and the construction of terraces now required by the government for upland crops on steep slopes. The area of upland rice grown on terraces has been increasing by almost 60% per year, with the yield in terraced fields steadily increasing from about 2 t/ha from 1995 to 3 t/ha in 2003, compared with an average yield on the slopes that has remained below 2 t/ha (Pandey et al. 2005, Tao 2005).

An IRRI survey of farmers' 2004 crop in Yunnan found that improved upland rice on terraces out-yielded traditional varieties on slopes by over 1 t/ha. On the slopes improved varieties out-yielded traditional varieties by 20%. More fertilizer is used on terraces (100 kg N and 42 kg P ha-1); on slopes improved varieties also get slightly more fertilizer (84 kg N and 42 kg P ha-1) than traditional varieties (69 kg N 37 kg P ha-1). The yield gains were translated into similar increases in net return. Upland rice farmers in the area who grow traditional varieties on slopes plant on average 0.36 ha/household, but those who have adopted improved varieties planted upland rice on only two thirds as much land (0.26 ha/household) on the terraces. On the slopes those who have adopted improved varieties also planted on less land, 0.29 ha/household, than those who plant traditional varieties (Data from IRRI 2005 survey, provided by S. Pandey). This apparent saving of land by the innovation of improved upland rice germplasm and increased inputs would indeed be promising for freeing the land for reforestation, but only if the set-aside land is not planted to more lucrative cash crops that could be even more destructive to the environment such as sugarcane.

The improved upland rice varieties have also demonstrated clear productivity gains in farmer-managed trials in eastern India and northern Lao PDR. The new upland rice varieties were shown to out-perform local check varieties in three ways: (1) higher grain yield and harvest index, Lao data also showed higher biomass; (2) consistency of the higher performance with and without fertilizer; and (3) greater responsiveness to nitrogen fertilizer (90 kg N/ha) (Atlin et al. 2006, Saito et al. 2006).

One important set of results from the IRRI upland rice work came from an on-farm trial in Luang Prabang, Lao PDR, in which yield gains in the combination of improved upland rice varieties and fertilizer application increased with decreasing yield of farmer's own upland rice crop, i.e. local variety and no fertilizer (Figure 2). The largest yield gains of up to 2.5 t/ha were made when farmer's own yields were lower than 1 t/ha. If this relationship holds for a wider range of environments, in other provinces of northern Laos and in other countries, it would mean that the opportunity for IRRI to provide a promising option for improving upland rice yields, and so local livelihoods of some of the world's poorest, is very great indeed. On the other hand, valuable insights might be gained from examining how some farmers are able get rice yields of 2.5 to 3.5 tons/ha with local cultivars and no fertilizer, that is as much as improved varieties achieve with fertilizer.

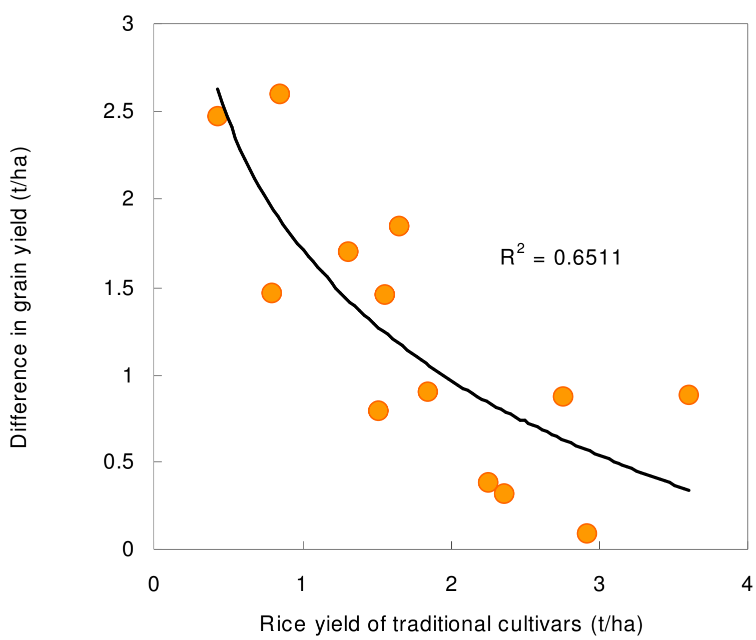

Figure 2 Grain yield of traditional cultivars under farmer management vs. the yield increase due to a package of improved cultivar plus inorganic fertilizer (60-60-60): 13 upland farms in Luang Prabang province, 2005 (Source: Saito 2005)

The new upland rice varieties are indica type selected in non-flooded, aerated soil. They have been shown to out-perform traditional tropical japonica varieties in favorable upland environments and on infertile soils. They are also superior to traditional varieties, with improved lodging resistance, harvest index and input responsiveness (Atlin et al. 2006). IRRI in collaboration with NARES has built up an impressive body of knowledge on this new upland or aerobic rice, which has laid the foundation for new innovations that should benefit breeding programs targeting water-saving efforts in irrigated rice and rainfed lowlands as well as those for the uplands.

To overcome major constraints of the uplands, the IRRI upland rice program has covered the whole spectrum from pre-breeding understanding, to identification of genetic control of tolerance or better adaptation to specific stresses and identifying, locating and mapping of relevant genes for deployment, and developing an appropriate methodology from marker assisted selection (MAS) to participatory variety selection (PVS) and transfer to national programs. PVS has been helpful in integrating farmers' preferences concerning grain types and relevant traits and genes into breeding programs. Several traits and genes that are likely to confer the ability to overcome important stresses in the uplands are ready, others nearly ready for deployment in breeding programs.

Genetic improvement for drought tolerance focuses on both moderate stress at flowering and severe drought stress. The physiological basis for this improved tolerance is being studied concurrently with mapping efforts. Genes for drought tolerance have been identified, and are expected to be deployed in breeding programs within three years.

Much improvement in blast resistance, in both defense against many races of the pathogen as well as durability of the resistance over time, is expected from the understanding that the efficacy of blast resistance is increased when genes for partial resistance are combined together in a single rice genotype. This strategy has already been incorporated into the breeding program.

Also being incorporated into new upland varieties being bred at IRRI is the gene *Pup 1*, which increases ability of rice roots to take up soil phosphorus.

The ability to germinate and establish well in anaerobic conditions, which occur frequently for short periods, has been identified as an important trait for good establishment in areas where upland rice is grown on heavy soils on flat land, especially in eastern India, Indonesia and the Philippines. This trait has been identified in several traditional varieties and is now being mapped; it is expected to be available for incorporation into breeding programs within two to three years.

Biotic stresses due to weeds, root aphids and nematodes build up rapidly under continuous cropping of upland rice, especially on light textured soils, so threatening the sustainability of intensive upland rice systems. Tolerance to these biotic stresses has been identified in traditional and other varieties. The physiological basis and genetic control of tolerance are being studied with a view to deploy the traits in breeding programs. In the case of weed competitiveness it was found that rice yield in weedy fields can simply be predicted ($R^2 = 0.87$) from early vigor and yield without weed stress. Seedling vigor is now routinely used for screening for weed competitiveness in the breeding programs at IRRI.

3.3 Addressing and Overcoming Constraints – Social Science Research on Upland Rice Farming Systems

Compared with the irrigated and lowland rainfed rice systems, the impact of upland rice research has been limited. In addition to the much smaller investment made in research on upland rice (in absolute amounts), upland rice research is also more difficult because it has to deal not only with complex agroecological niches, but also with extremely heterogeneous socio-cultural, institutional and economic conditions (see above).

Social science research at IRRI includes important aspects such as understanding rural livelihood systems, interactions between technology, institutions and infrastructure, and constraints to the adoption of improved rice varieties and technologies. It also assesses poverty impacts of rice research and the requirements of sustainable management of natural resources. These activities in general serve the rice research community as well as policy makers. They are particularly useful in adjusting research priorities and in assessing ex-ante problems in adoption processes, as confirmed by the 6th EMPR. Considering the complexity of the upland environment, they are of particular importance when breeding successes are not easily adopted by upland farmers due to the above mentioned socio-cultural, institutional and economic constraints.

Past research has to a considerable extent been directed at understanding farmers' practices, knowledge, constraints and livelihood strategies and defining the complexity through socio-economic and natural resource management studies. Research results have been fed into breeding and genetic improvement programs and in this way have strengthened the basis for developing farmer-relevant and -appropriate technologies. IRRI has also contributed significantly to increase knowledge about the upland environment.

Beginning with a small study in northern Thailand in the early 1990's (Thong-Ngam et al. 1995), an intensive study of land use changes and farmers' livelihoods in northern Vietnam (a collaboration between VASI, IRD, CIRAD and IRRI), and a typology of the Asian uplands has been developed (Pandey 2000, Pandey and Khiem 2001, Castella and Quang 2002, Phouyyavong et al. 2004). IRRI's research is now conducted within the framework of CURE where IRRI is working closely with national research and extension organizations, local development agencies, NGOs, community leaders and farmers. These stakeholders are involved in all stages of the innovation generation and diffusion process, such as problem diagnosis, identification of technological opportunities, implementation of research programs, innovation validation and adaptation (Pandey et al. 2005).

For the development of upland rice farming systems it is important to understand the role of upland rice in the livelihood system of upland farmers. Particularly policy makers often viewed the uplands mainly as source of timber and other valuable natural resources and neglected the importance of food crop production. For most of the rural households in the uplands, especially the poor, rice remains the most important source of food and income (Minot et al. 2006). Many of these farmers, who lack access to infrastructure and markets and who are to a high degree dependent on upland rice, live under chronic food deficit even in countries with a rice surplus at the national level like Vietnam (Pandey et al. 2002).

Social science research at IRRI also analyzed the reasons why farmers continue to grow upland rice even if productivity is low or policies are set to discourage production, as is the case in Vietnam and Laos (Pandey 2004). Upland rice offers an opportunity to spread the use of labor more evenly over the seasons of the year and to reduce price risks that come along with cash crops. It is also harvested early and thus helps to shorten the "hunger" period before the next harvest. Typically, upland rice farmers have low opportunity costs of labor and land, and therefore it makes economic sense to produce their own upland rice instead of buying it (Pandey et al. 2005). Also institutional factors, such as the observation made in the Son La region of Vietnam where in case of over-indebtedness and credit default upland rice cannot be confiscated may play a role (Dufhues 1999).

Another important issue concerns preferences and quality features of upland rice. Generally, the impact of improved upland rice germplasm in meeting local food needs requires that the improved rice varieties suit the local tastes and preferences. Farmers' preferences for certain characteristics, such as locally preferred grain types, and their objection to others are being identified in PVS. Cooking and tasting tests have also begun to be taken up in PVS trials. Integrating the identified preferences into breeding programs requires to identify relevant traits and genes. These approaches are increasingly contributing to solve a variety of problems. Understanding of people's rice quality preferences, however, is still limited, especially in the uplands populated by so many different ethnic groups. Similarly lacking is the understanding of traits and genes that are involved in taste and quality. Limited understanding of the requirement for grain quality in upland rice could very well be a bottleneck that impairs the outputs from upland rice research from having the intended impact on local livelihoods. To tide them over rice deficit months, upland people may buy lower grade rice from the lowlands as has been reported in northern Thailand (Kaosa-sard et al. 2005) or eat more non-rice food such as maize, cassava, other root crops, etc. However, it would be too simplistic to assume that they would readily grow just any rice with higher yield. Similarly short-sighted would be to prejudge that farmers will not adopt any new varieties except those with exactly the same grain quality as their current varieties. After all, variety turnover is common among rice farmers of the uplands, with new varieties continually being acquired, evaluated and adopted from other villages and ethnic groups, across provinces, and sometimes across national borders. During the review team's visit to an IUARP site at Pak Chaek village in Luang Prabang, a Tai Lue farmer reported that he was happy with a trial planting (10 kg seed) of a variety called Kao Daw (simply early rice in Lao/Tai/Thai) acquired from another village. Empirical evidence from India showed that yield advantages can be neutralized by lower prices when newly adopted varieties fetch lower prices due to a lower quality or other preferred characteristics (Janaiah and Hossain 2003).

Socio-economic analyses of major constraints of upland farming systems revealed that institutions and policies play an important role. The lack of land tenure security leads to low incentives to invest in the land. Policy reforms are also needed to integrate upland systems with the rest of the economy by providing infrastructure and market institutions to improve market integration and competitiveness of agricultural production in the uplands (Pandey 2004). An example that underlines the need for proper institutions and policies to support technology adoption is the successful intensification strategy of upland rice systems in Yunnan discussed above. Terrace promotion, availability of inputs and land tenure security were the basis for increased productivity through new rice technologies there (Pandey et al 2006 forthcoming). Also in northern Laos, a study (Schiller et al. 2006, forthcoming) found that access to credit could be decisive for investment decisions; the highly profitable investment in montane paddy terraces was facilitated by access to credit.

These achievements are outcomes of IRRI's cooperation, balancing and integration of basic research to increase knowledge about rice in the upland environment, of socio-economic work to understand the cropping and farming system context and of breeding efforts directed at clearly defined problems.

3.4 Agroecological Research

Biotic and abiotic stresses of upland rice production identified earlier in Thailand were verified by IRRI and its partners in Lao PDR (George et al, 201; Roder, 2001) and Vietnam (Castella and Dang Dinh Quang, 2002). These provided basis for germplasm improvement work for better phosphorus uptake, weed competitiveness and resistance to biotic stresses discussed above. Numerous cropping systems were and continued to be tested, to improve soil fertility (Roder, et al, 1998; Saito et al, 2006) and protect the soil (e.g. Morize et al., 2005). There was, however, very little evidence that these have been taken up by farmers. During the field visit in Luang Prabang the review team was informed by farmers and local researchers that pigeon pea, introduced for soil improvement, was effective, but the crops were hard to sell.

In the meanwhile, reports about farmers' own sustainable land use systems that are reasonably productive have begun to come from other researchers in the region. Rotational shifting cultivation systems that produce satisfactory upland rice yields in relatively short cycles of 6-7 years can be found in northern Thailand and Lao PDR (Yimyam et al, 2002; Vilayphone, 2006). In northern Thailand, upland rice that was being rapidly displaced by cash crops in some areas in the 1990's is coming back. Upland rice in rotation with cabbages and other heavily fertilized and clean weeded cash crops can yield 3-4 t/ha (Rerkasem et al., 2002). Local varieties like Ble Chao and Bue Cho that are particularly responsive to improved soil fertility are sought after. This may be an ideal opportunity for IRRI's improved upland rice varieties to have an impact, if the rice can be made acceptable to local tastes.

Collaboration with the French SAM project, which employed new tools such as the Multi-Agent Simulations has helped to improve understanding of complex upland agroecosystems (Bousquet et al, no date). IRRI is to be commended for its proposed paradigm shift (see next section 3.5) to move from the crop field to cover trade-off between livelihoods and conservation, interactions between uplands and lowlands, and competition for water and land between different groups of people. IRRI's Water and Food Challenge Program project in the uplands with Lao PDR, Thailand and Vietnam, ICRAF, CIRAD and University of California, Davis should be able to draw on lessons learned, especially in light of recent social, political and economic changes, by the different collaborating groups in different countries. For example, the work on Mae Chaem Watershed in northern Thailand by ICRAF and its partners has shed lights on conflicts over dry season water between different ethnic groups and the highly dynamic ways in which communities try to cope (Badenoch, 2006).

3.5 Uplands Rice Research at a Turning Point

Indications that IRRI's upland rice research is poised to contribute to increasing productivity in the uplands may be found in research results detailed above. Further gains in yield stability as well as sustainability of continuous upland rice can be expected from the deployment of traits and genes for tolerance to various biotic and abiotic stresses. That a considerable amount of improved upland rice seeds from Yunnan is already finding its way across the borders into Lao PDR and Myanmar proves that these new upland rice varieties are already meeting the needs of upland farmers in these countries.

Also, as IRRI's strategy paper for upland research (Pandey et al. 2005) states, "the paradigm shift that indicates a move away from the purely upland rice plant-oriented research to a broader systems-level research agenda aimed at managing upland-lowland interactions for improved household food security and environmental protection represents a significant departure from the past in IRRI's upland research. The suite of available improved technologies ready for farmer adoption and in the pipeline offers opportunities for generating significant environmental and poverty impacts in upland 'poverty hotspots'. In addition, the multidisciplinary and multi-institutional collaboration that IRRI is fostering will yield long-term dividends by building the foundation for holistic and integrative approaches to upland development." The study team supports this conclusion.

4. IRRI'S ROLE IN UPLAND RICE RESEARCH VIS-À-VIS NARES

4.1 IRRI's Experience in Uplands Rice Research

IRRI started its work on "less favorable rice production areas" (to which the rain-fed uplands belong) during 1970-1980 with the introduction of farming systems research. This was the first systematic effort in rice research to address the problems of rice production in unfavorable areas, including the highly complex small farmer subsistence systems in upland areas (CGIAR 2005, 6th EMPR-report).

The major emphasis was on raising productivity through genotype improvement and better resource and crop management in both the uplands and the rain-fed lowlands. Parallel to its work on less favorable rice areas, IRRI initiated in 2000 research on aerobic rice systems (CGIAR 2005, 6th EMPR-report). While driven by other concerns, i.e. mainly water scarcity considerations, this research has the potential of significantly contributing to the uplands rice work and its potential impact. In fact, part of the research on aerobic rice with promising results for a combination of improved varieties with different N and P applications is carried out in the rain-fed uplands. Yields are reported to have increased from 1.5-2.0 t/ha for traditional varieties to 3.0-4.0 t/ha for improved varieties with fertilizer application (Saito et al. 2006, see also Atlin et al. 2006).

IRRI's experience in uplands rice research accumulated over more than 20 years together with the manifold contributions to uplands rice research from its other programs, notably its aerobic rice work, render it an important source of knowledge and experience that many of the NARES, particularly the younger ones, do not have. Representatives from the NARES unanimously pointed out how highly they value IRRI's germplasm and research experience with disease resistances, weed competition, drought and cold tolerance, maturing periods and other traits for their work in the specific environment of their country. Also, this study team agrees with the conclusion of the 6th EMPR, that research for unfavorable environments "will need even more emphasis because the NAR[E]S have less capacity to work in the unfavorable systems comprising much of the rice growing area." (CGIAR 2005, 6th EMPR-report: xxxiii).

4.2 Investing in Uplands versus Rainfed Lowlands and Irrigated Rice Research

The question whether IRRI should devote scarce resources to upland rice research should be based on an assessment of uplands rice research investments' relative impact on production growth and poverty reduction. There is no doubt that both, as a result of IRRI's work as well as contributions by others, rice production and productivity has risen enormously, providing food for continuously increasing populations at stable and often decreasing rice prices. This enormous achievement is largely based on research results for the more favorable areas, particularly the irrigated rice systems; the unfavorable areas, notably the ecologically complex uplands regions, have contributed relatively little. Upland rice research is questioned mainly because of its relatively small impact on overall rice production increase.

As the 6th EMPR-report points out, increased rice production has been essential for poverty reduction in Asian countries. First, it raises farmers' income and thus can reduce poverty, even though farmers in irrigated areas, for which the improved technologies worked best, are generally not the poorest groups in rural areas. Still, the intensified rice production created new jobs and expanded employment and income opportunities, including for the landless poor (Otsuka 2000). Second, and perhaps most importantly, increased rice production helped to reduce poverty by lowering rice prices for poor urban and the many poor rural households that have to purchase rice, often to complement their own insufficient subsistence production (Fan et al. 2005). Third, the rising rice supply helped to reduce the food constraint and thus made an accelerated economic growth and employment possible (CGIAR 2005, 6th EMPR-report). These are most important pathways out of poverty and their proper functioning in the future are likely to remain vital also in the foreseeable future.
However, there are also signs that the return to investments in the high potential areas may not be as high in the future as they have been in the past. Thus, Fan and Hazell find that in India, during 1970 and 1994 "agricultural production grew fastest in the high potential rainfed areas (3.58% per year), followed by irrigated areas (2.68%) and the low-potential rainfed areas (2.26%). (…) Production growth in irrigated and high-potential rainfed areas slowed in the early 1990s, whereas it increased in the low-potential rainfed areas to 3.77 percent per year, more than double the rate of growth achieved in the 1970s." (Fan and Hazell 1999). Still, they conclude that investments in the more favored areas remain important. IRRI's continued emphasis on more favorable areas remains well based, both on growth and poverty reduction grounds.

At the same time, the emphasis on favorable environments in research is bypassing large parts of the uplands, that is major poverty areas, particularly those that are remote, not linked to infrastructure and communication systems, and thus not integrated into markets and not reached by institutions, such as extension, credit and modern input supply. Farmers in these areas being predominantly subsistence farmers are generally very poor, use the natural resources on partly extremely sloped terrain which, with increasing population pressure, leads to a degradation of natural resources and a destruction of the environment.

The question of how to allocate the resources for agricultural research between more and less favored regions has been the topic of many studies (Akino and Hayani 1975, Ramalho de Castro and Schuh 1977, Ayer and Schuh 1972, Scobie 1976). Looking at rice research in Colombia Scobie concluded that the "development of technology suited to such areas is presumably a more difficult process, which ceteris paribus, would divert research resources from the discovery of technologies which can result in rapid increases in total output from the more favored commercial agricultural sector. (…) Concentrating the research on upland producers would presumably have entailed foregone benefits to the numerous urban poor (without guaranteeing that small upland producers would have benefited in the long run)." (Scobie and Posada 1978: 90). Also Otsuka (2002) in his review of Green Revolution Experience in Rice Production in Asia, drawing also on earlier studies such as David and Otsuka (1994) and Otsuka et al. (1994), found that developing new varieties for unflavored production environments is much more difficult and their effect tends to be marginal. They conclude that if research focuses on marginal areas, it will have limited impact on both productive growth and welfare of the poor. Thus, allocating research resources to developing varieties for unflavored areas cannot be justified from the viewpoint of either efficiency or poverty reduction. He argues against rice research for unflavored areas "simply because the development of appropriate technology can hardly be expected" (Otsuka 2000: 460).

However, there are new developments in aerobic and uplands rice research visible. Different from past experience it now appears that long-lasting efforts in uplands rice research come to bear fruit. There is increasing evidence for a substantial potential to increase productivity in upland rice production. Research results addressing important limiting factors such as soil-borne pests, weed competition and soil erosion are available and, as pointed out earlier, the deployment of improved cultivars is currently taking place. There are also promising research results regarding traits and genes that are likely to confer ability to overcome important stresses, which are ready or nearly ready for deployment in breeding programs. Also, new insights on quality issues and preferences offer new opportunities for the successful adoption of cultivars. Thus, the basic premise that led to many former studies' conclusions against research investments in the uplands appears to have changed. Otsuka indicated that in view of recent progress in unfavorable uplands and aerobic rice research and persistent poverty in the uplands, a larger amount of resources should be allocated to research for unfavorable areas (Otsuka, personal communication to SC Secretariat 2006).

Additional reasons that argue in favor of investing in research directly for these areas are:

- If agricultural research is to contribute (in addition to the general pathways out of poverty discussed above) also to poverty reduction in mountainous remote regions, it needs to devote part of its resources to the poorest and admittedly most difficult areas, the uplands. Research investments for the more favorable areas, for all their positive impact on poverty reduction via the price effect, the employments/income impact and the multiplier effects will do little for those people living in the remote mountainous regions which are not sufficiently linked to markets and infrastructure for these effects to reach them. Even the argument and evidence that Otsuka (2000: 448) quotes for the poverty reducing effects of the Green Revolution, i.e. "that benefits of the Green Revolution technology in favored areas accrue to unflavored areas through inter-regional labor migration from the latter to the former areas" cannot be easily transferred to those mountainous regions where, apart from the high costs of migration, also language, lack of education and qualification and ethnic barriers prevent people to migrate (Baulch et al. 2002, Dang et al. 2003). The ongoing "Uplands Research Program" of the University of Hohenheim, where research in the northern highlands of Vietnam and northern Thailand is being carried out, finds also cases of high migration barriers by policies that deny members of ethnic minorities nationality and concomitantly access to schools and training facilities. Thus, the spill-over effects from more favored to most difficult areas that build on interregional migration cannot take hold (van de Walle and Gunewardena 2000).

- Second, the uplands are exposed to enormous pressure on their natural resources. Population growth, migration and settlement policies and, in some countries, poppy substitution policies, are prime reasons, setting environmental destruction processes in motion that take on self-escalating speed. In raising productivity in the more favorable lands of the upland areas upland rice research could help to release the pressure on the most fragile lands, and free them for reforestation and resource conservation activities. Whether these lands will go to reforestation and conservation is also a question of national policies to set proper incentives. It may be necessary to provide incentives for reforestation to avoid the freed land being switched to higher value cash crops that could be even more destructive to the environment.

- Third, there is a valuation issue involved. Even if upland research investments are yielding a lower output in quantitative terms this does not necessarily mean lower output in value terms. If in evaluating research output one were to use social pricing, income distribution and the different marginal utility of income, dependent on where in the income distribution spectrum the beneficiary of the production increase is located, becomes relevant. Additional rice produced in poorer areas would be valued higher than rice production increase produced in wealthier regions (Squire and van der Tak 1975). While the specific multipliers to be used for the poorer and wealthier regions, respectively, might give ample room for debate, the principle of increasing marginal utility with declining income is sound and generally accepted. For the question at hand, how to assess the output of uplands versus more favorable lowland rice research, it means that in using simple efficiency pricing, as is generally done, the upland research output is certainly undervalued; by how much is difficult to assess.

The remoteness of mountainous regions also raises the question whether farmers in those areas can get access to and use the necessary seeds and fertilizer. Lack of roads and high costs of market access in remote areas certainly hamper the marketing of output as well as the procurement of knowledge, seeds and fertilizer. Spreading innovations and deploying better seeds in the more difficult areas requires a package approach accompanying new seeds with support measures that facilitate input supply and bring extension and rural finance services into the remote areas (von Braun et al. 2005). Still, the quantities in seeds and fertilizer to be supplied would be substantially less than procuring rice directly for food security, particularly if organic matter and manure are being used for raising soil fertility.

In this study team's view, there are important reasons for IRRI to stay involved in both, the high potential lowland rice research and, at the same time, to continue its upland rice research. It needs to find the proper balance between the two. This study team is of the opinion that a minimum allocation, as discussed below in chapter 5, is needed to achieve a significant impact.

4.3 IRRI as the Center of the Consortium for Unfavorable Rice Environments (CURE)

IRRI plays a central role in CURE, a collaborative management network of IRRI and participating NARES, in which IRRI and the NARES jointly identify, select and prioritize regional research needs, carry out interdisciplinary research on the productivity and sustainability of rice based farming systems, and exchange and evaluate germplasm and technological innovations.

CURE focuses on training and capacity building in the partner NARES, on the needs of poor farmers in unfavorable environments and more recently on farmer participation socio-economic analysis and dissemination and adoption of research results.

The sixth EMPR "*commends IRRI for its efforts and effectiveness in developing the consortium approach for integrated multi-locational research into a true partnership research system for impact with a clearer role for IRRI staff*". This study team found the sixth EMPR acknowledgement fully confirmed, both by the NARES representatives and its own findings. IRRI has taken on a leadership role and is essential for the functioning of CURE, as it contributes very valuable and highly esteemed (by NARES) scientific knowledge and methodical competence on data compilation, management and analysis. IRRI also plays an important mediating role in promoting information and germplasm exchange between NARES. It is highly doubtful whether CURE could be functioning without IRRI's central role in it. Similarly IRRI's involvement in CURE was essential in ADB's decision to provide financing for the consortium activities. Moreover, IRRI's advice on technical innovations in rural development programs is widely sought by bi- and multilateral donors as well as NGOs active in the Asia region.

Two effects of IRRI's involvement deserve particular mentioning:

a) Mobilization of Funds

IRRI has been mentioned as an important factor in mobilizing resources for rice research in the uplands. The SAM-project in the Vietnam uplands, financed by CIRAD, is closely collaborating with IRRI. On that basis, an expanded continuation of the project is planned for the future. Similarly, in the Swiss support for upland rice research and capacity building and the Australian support for the Cambodian program, IRRI plays an important role as well in the World Bank, EU and JICA funding of the Philippine rice research program. Also NARES representatives point out that the national priority setting and support for upland rice research heavily depends on IRRI having a focus on upland rice research. New initiatives are commencing with an IRRI-IFAD project that will involve Lao PDR, India, Nepal and Vietnam and the IRRI Water and Food Challenge Program project in the uplands with Lao PDR, Thailand and Vietnam, ICRAF, CIRAD and University of California, Davis.

To demonstrate the importance of uplands rice research and help in the mobilization of funds it would be advisable for IRRI itself to devote a minimum of its own funds to the uplands program. In substantially reducing its core funding for upland rice over the last years, IRRI itself may have sent signals that might diminish that role, particularly if interpreted to indicate low priority for upland rice research. Thus, IRRI would be well advised to maintain a credible allocation of core resources to its upland rice program.

b) IRRI as an important contributor to the pool of knowledge about rice in the uplands

In this CURE partnership, IRRI has demonstrated its unique and essential role as provider of basic understanding in rice science that is directed and channeled into development of germplasm and methodology that can be used to solve especially difficult on-farm problems of the uplands.

National programs generally focus more on the natural science side of rice research. IRRI's involvement is particularly advantageous in promoting close integration of socio-economics in rice research. This has led to better understanding and conceptualization of the condition in the uplands, which has enabled the natural scientists to focus on improving definition of the biophysical constraints and describing genotypic variations in rice responses and identification of useful traits and selection methods for use in breeding programs.

Deployment of knowledge about, as well as genes for, drought and blast resistance and weed competitiveness, in breeding programs in countries from Indonesia, the Philippines, Thailand, Laos and Cambodia illustrates the important role of IRRI as provider of knowledge about the uplands, upland rice and its role in local livelihoods in 3 ways: (1) as source of basic understanding in ecophysiology and genetics of tolerance/resistance to stress and integration of socioeconomics, (2) bringing cutting edge science and methodology to bear on research approach and transfer of results to NARES, (3) synergies and feedbacks between programs for other ecosystems, e.g. spillover of outcomes into rainfed lowland rice programs including the one in Cambodia which is not even a member of the Upland Working group of CURE.

Capacity building in the NARES has been much more effective when coupled with active research focusing on specific problems, while at the same time transferring and adapting the latest methodologies for local use, from participatory research and germplasm evaluation to the latest molecular analysis and marker assisted selection. The fruitfulness of this research is illustrated in significant improvement in our understanding of rice adaptation and resistance to well known stresses, i.e. blast and drought. Application of this knowledge to address these problems, IRRI's pioneering work on new biotic stresses (weeds, nematodes and root aphids) is likely to benefit research of the water saving or aerobic rice of the lowlands as well as permanent cropping of upland rice. The uplands with their complexity and multiple and diverse constraints are especially valuable as a training ground for national rice scientists. However, the impact of IRRI upland rice research could be enhanced by increasing the capacity for basic rice research directed at specific local problems and opportunities within the NARES. IRRI's role could also be enhanced by making full use of the substantial experience in uplands rice research accumulated outside Asia, for example in EMBRAPA in Brazil. Strengthening partnerships with those institutions would be advisable.

5. RECOMMENDATION ON THE SIZE AND COMPOSITION OF IRRI'S UPLAND RICE RESEARCH PROGRAM

All evidence suggests that IRRI's upland rice research is at a stage where it can make important and rising contributions to increasing rice productivity and reducing poverty in the uplands. IRRI's rice research for the uplands can provide substantial research outputs for understanding the uplands and the role of rice in it, raising rice yields substantially and developing improved germplasm with traits and genes for meeting specific requirements of the uplands. It also can support and help build capacity in the NARES and provide technical inputs into in-country development programs (e.g. the Lao-IFAD).

To be able to achieve this at any significant level the study team would recommend a minimum of technical inputs from a team of 3 scientist-equivalents: one breeder; one agronomist with experience in ecology and cropping systems and participatory research competence; and one economist with social science background. Cross disciplinary interactions and experience in all three would be essential. In collaboration with the NARES partners, along with assistance in capacity building, the team's responsibilities would include:

1. carrying out the upland rice research program, linking up with IRRI's other programs and deploying research outputs and outcome already achieved there;
2. identifying constraints of and opportunities for these research outputs to have impact on local livelihood in the upland;
3. creating further outputs and linking up with NARES in the effort to contribute towards improving upland rice productivity.

An important task of the team would be to test IRRI's central research hypothesis for the upland environments - i.e. that to raise rice yield requires essentially the combination of improved rice varieties and fertilizer (in many cases just nitrogen). The premise of IRRI's main approach to improving return from upland rice production is through improving the germplasm by identification of required traits and deploying them in the breeding programs. There is enough evidence that suggests IRRI's central hypothesis to be plausible; however, it needs to be tested over a wider range of upland environments, taking into account deployment of traits and genes already identified to overcome constraints to yield responses in the uplands. At the same time, it would be worth pursuing how some upland farmers are already able get rice yield of 2.5 to 3.5 t/ha with local cultivars and no fertilizer.

Local acceptance of the improved upland rice germplasm emerges as a key bottleneck for the increased yield potential to have real impact on local livelihoods. Thus, research needs to integrate local preferences and constraints into the research work. This could include research aiming to (1) understand grain quality requirements and their dynamics, among the different ethnic groups who make up the upland population, and (2) identify specific quality requirements and traits that can be incorporated into the breeding program. The team might also explore the potential of market opportunities for high quality upland varieties. In addition to these team efforts, individual scientists would have specific responsibilities.

The breeder would be responsible for continuing the breeding program aiming to improve upland rice germplasm, incorporating traits and genes in the pipeline and collaborate with the NARES evaluating these on farm and develop further the participatory variety selection methodology to include local preferences for grain quality.

The agronomist (with cropping/farming systems experience to cover soil, soil fertility, plant nutrition, cropping pattern and crops interactions) would be responsible for identification of constraints for the realization of yield potential and adoption of the new upland rice germplasm on farm. He/She will work together with the socio-economist to identify social and economic conditions for farmers' adoption of the new varieties.

The socio-economist would study the determining conditions of rural livelihood, poverty and food insecurity with particular emphasis on the rice economy, to do research to promote the understanding of the uplands cropping and farming system within the socio-cultural and economic and policy-institutional context and analyze the role of rice within the uplands production and household system. The role of the socio-economist is crucial as in the uplands socio-cultural, institutional and economic factors interact with technology generation and adoption. Successful adoption of research results and determining factors, and impacts on poverty alleviation should be supported and monitored by the socio-economist.

The team members would also carry out an important function in capacity building in NARES. Modest additional resources made available for in depth, good quality rice science, conducted by local scientists within the framework of the upland rice consortium and directed at the uplands would go along way towards the build up of local capacity that brings together basic understanding of rice in one of its most difficult environments and local insights, as well as contributing to solutions for upland problems.

Where the upland research is best located is a question that the study team found difficult to address. Certainly close interaction with IRRI's other programs would be essential, particularly for the breeding work. On the other hand, being close to uplands environment would be beneficial particularly for the work on ecology and cropping/farming systems. In deciding the location question, also the amount of time and resources spent on traveling would be an important consideration.

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Annex I

Terms of Reference for an External Assessment of IRRI's Upland Rice Activities in Asia

Background

In response to the recommendation of the 6th IRRI EPMR, the Group requested Science Council to establish an independent panel to study the situation of upland rice in Asia and IRRI's potential contribution to solving researchable issues vis-à-vis the potential contribution of NARS or other parts of the CGIAR System.

Approach

The Science Council will appoint a two-member team with strong expertise in relevant areas of economics, and familiarity with rice and the pathways for development for the upland rice based systems of the Asian region to carry out the study on IRRI's role and comparative advantage on rice research and activities in the uplands in terms of likelihoods of impacts from research and relative effectiveness of research investment.

The study will be based on literature review, virtual interviews and surveys if needed, and fields visits to the most relevant locations in South-East Asia.

Terms of Reference

The team will review IRRI's past involvement in rice research in the uplands, covering all relevant areas of research, to assess the outputs, outcomes and plausible or documented impacts from that research.

The team will analyze the driving forces for the development of the various rice based upland systems in Asia identifying the continued role of rice and thus the relevance of improved rice systems in the development pathways.

On the basis of IRRI's past experience and outcomes from research in the uplands, and in the context of the likely future development trends of the uplands, the team will examine the comparative advantage for IRRI as a rice based research center in effecting plausible outcomes and impact in the uplands compared to the roles of alternative research and development providers, including national research institutions, CGIAR Centers and NGOs.

The study report will contain analysis about the opportunity for rice research as a driver for change in the uplands and explicit recommendations on whether IRRI should continue research on rice systems in the uplands, and if so, recommend a minimum level of involvement in terms of resources and/or partnerships without which IRRI does not have the needed critical mass to have impact.

Time frame and delivery

The task is expected to take a total of about 40 working days including field visit. The Science Council Secretariat will provide necessary resources, such as assistance in conducting any surveys. A draft report is expected by January 15th, 2006. The final report should be delivered by March 1st, 2006 for the Science Council to discuss at SC5 in April 2006.

Annex II

Itinerary, people the review team (FH and BR, except where specified) met and held consultation with

4 Dec 2005 pm	Benjavan Rerkasem met with Sushil Pandey in Chiang Mai, Thailand
8 Dec 2005 am	BR met with director and research staff at Chiang Mai Rice Research Station at Sanpatong, Chiang Mai Dr. Waree Chaitep Dr. Prateep Pintanon Dr. Vichai Kumchompoo Dr. Nipon Boonmee Dr. Sakul Moolkam Dr. Somkiat Wattakawigran Dr. Premrudee Pintaya
11 Dec 2005	Team Travel to the Philippines
12 Dec 2005	Meeting with Dr. Robert Zeigler (IRRI Director General); Dr. Wang Ren (IRRI Deputy Director General for Research Briefing and discussion with IRRI upland rice research team and representatives from NARES IRRI – Upland rice team Dr. Sushil Pandey Dr. Gary Atlin Dr. Edwin Javier Dr. David Johnson Dr. Nollie Vera Cruz
13 Dec 2005	Meeting with Dr. William Padolina, IRRI Deputy Director General for Partnership and with NARES representatives and IRRI staff Indonesia – Dr. Sumarno The Philippines – Dr. Rosa Fe Hondrade India – Dr. M N Shrivastava Nepal – Dr. N P Adhikari Dr. Nollie Vera Cruz Dr. Sushil Pandey
14 Dec 2005	Presentation of upland work in Lao PDR by Dr. K. Saito and discussion (also with Dr. Sushil Pandey and Dr. Gary Atlin) Travel to Hanoi
15 Dec 2005 am	Briefing at Vietnam Academy of Agricultural Science: Northern Mountainous Agriculture and Forestry Science Institute (NOMAFSI) Dr. Le Quoc Doanh Dr. Nguyen Tri Hoan Dr. Le Vinh Thao Other staff of NOMAFSI Dr. F Affholder (IRRI-CIRAD)
pm	At IRRI office meet Prof. Tran Chi Thien (Rector, Thainguen University of Economic and Business Administration) with Dr. F Affholder

16 Dec 2005 am	Travel from Hanoi to Vientiane Visit and briefing at Lao-IRRI by Mr. Kouang Doungsila, Director of Lao Rice Research Program, Dr. Gary Jahn, Lao-IRRI Project Manager and Prof. Tao Dayun, Deputy Director, Food Crops Research Institute and Direcor of the Key Laboratory for Crop Breeding of the Yunnan Academy of Agricultural Sciences Meeting with Dr. Carl Mossberg, Senior Program Management Advisor, Lao-Swedish Upland Agriculture and Forestry Research Program
pm	Dr. Ty Phommasak, Vice Minister for Agriculture and Forestry, Dr. Phouangparisack and Dr. Soulivanthong Kingkeo, Deputy Director General of NAFRI Discussion on Yunnan new improved upland rice production system with Prof. Tao Dayun from Yunnan Academy of Agricultural Science
17 Dec 2005 am pm	Travel from Vientiane to Luang Prabang Briefing at Northern Agricultural and Forestry Research Center (NAFReC): Mr. Saysana Inthavong Mr. Vilaphong Mr. Khamla Phanthaboun Mr. Khamdok Songyikhangsuthor
18 Dec 2005 am pm	Visit IUARP field sites and farmers: accompanied by Mr. Houmchitsvath Sodarak Head of NAFReC and staff Farmers visited: Mr. Kong Kantanam, Pak Chaek village Mr. Mun Inthachak of Hutxua village Return flights home
21 Dec 2005 am	B. Rerkasem discussed with Dr. David Thomas of ICRAF (office in Chiang Mai University), re upland rice in the Alternative to Slash and Burn (ASB) project and new collaboration.