

### 3 RELEVANCE AND QUALITY OF SCIENCE

#### 3.1 Relevance of science

WARDA's mission and strategy were discussed in Chapter 1. In this chapter, the Panel comments on the priority setting process and the relevance and quality of science, including the importance given to research on upland, lowland and irrigated rice, and the program balance between applied and strategic research, disciplinary and integrated research, and genetic and non genetic solutions to the research problems addressed by the Center.

##### *Research priority setting*

WARDA, as part of the preparation of the Strategic Plan (SP) 2003-2012, set up an internal task force to develop research priorities. Knowledge gap analysis was performed, constraint levels were scored, potential impact indicators were considered and all member countries were consulted through the task force mechanisms (ROCARIZ), as well as WARDA's National Experts Committee (NEC) and Council of Ministers (COM). The NEC had two meetings on this topic. The Board also spent considerable time discussing the draft SP. Basically, the research priorities were based on scientist expert judgments. However, because of the turmoil caused by the "Ivorian crisis", the process of priority setting was not as systematic or rigorous as was done for the previous SP. In contrast, for ECARRN, a network in which WARDA also participates, ASARECA used the ISNAR process of priority setting which is a more elaborate and well established process.

The Panel received a presentation by staff on the issue of research priority setting, explaining the principles and methodology used by WARDA. Both are well in line with the SC recommendations. The process is indicated as being continuous. It outlines the nature of the information needed but concludes, "such information is currently lacking for most constraints". Thus, the *Panel encourages WARDA to collect the needed information*.

The SP 2003-2012 outlines the general principles that are relevant for setting research priorities. The Panel believes it is appropriate to include such criteria as the importance of the research issue, "researchability" of the scientific question or constraint being addressed, the probability of success, its likely potential impact, and WARDA's comparative advantage in undertaking the research. The Panel, however, perceives some level of discrepancy between the acceptance of these general principles and their practical application in the priority setting process at WARDA, in part due to the paucity of information referred to above, but also due to the manner in which available information is used at various stages of this process.

We believe the priority setting process would be improved by separately considering the criteria that can be quantified (e.g. yield losses due to various constraints) and considerations that are more a matter of judgment, such as the assessment of country research capacity or the capacity to solve the problem in a defined period of time. The data Tables provided in the SP 2003-2012 by country and ecosystem, classifying constraints into three categories, were useful in this respect, but a real quantification in term of yield losses would be even more interesting. A methodology to perform a scientific analysis of yield gaps due to pests and diseases in the field has been designed and applied in Asia.<sup>90</sup> It is certainly costly and complicated since it involves experimental approaches, but it would give tangible support to a research focus on one or, more

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<sup>90</sup> Savary S, Willocquet L, Elazegui FA, Castilla N, Teng PS, Rice pest constraints in tropical Asia: Quantification of yield losses due to rice pests in a range of production situations, *Plant Disease*, 2000, 84:357-369.

realistically, an association of constraints. Similar methodologies exist to quantify the other types of constraints.

If this were done, and proper weights were assigned to different criteria included in the priority setting exercise, it might be possible to reduce discrepancies between good intentions and actual practice. An example of such discrepancies is the fact that the overwhelming importance of weeds in the upland and lowland ecosystems was regularly mentioned in the SP, but, until mid-2007, WARDA did not have a senior weed specialist nor was weed competitiveness a target in its molecular genetic projects. Other similar examples can also be given, where it was clear to the Panel that even though an exhaustive list of constraints was presented for each ecosystem, there was insufficient indication of how one constraint was weighted in comparison with another, and how the resultant priorities adequately addressed unmet research needs.

In terms of the relative balance between WARDA's current programs, the SP 2003-2012 set the following program priorities: Program 1: Integrated Rice Production Systems (with 4 projects): 65% of resources; and Program 2: Rice Policy and Development (with 3 projects): 35% of resources. However, the analysis of the actual expenditures of the Programs shows that the trend is actually decreasing, with Program 1 receiving 63%, 57% and 53% of the research resources in 2000, 2003 and 2005 respectively. The justification for this decreased relative priority is not discernable from the available documentation. In the Panel's view, based on its assessment of these Programs in Chapter 3 and the research gaps that still need to be met, this decreasing trend needs to be gradually reduced, so that Program 1 again receives about two-thirds of the total research budget, as envisaged in the Strategic Plan for 2003-2012.

The Panel is concerned also that translating the above priorities into appropriate MTP priorities and projects is complicated by the requirement by the Science Council that a "rolling" MTP be prepared every year. This scatters the information in several documents, and represents an unnecessary administrative burden for the Centers. WARDA, like other CGIAR Centers, has conscientiously prepared such plans; and has discussed them annually at the research program, institute management, and Board/Program Committee levels. Despite these several levels of discussions, the scope and depth of MTP discussions, and hence the actual process of research planning and priority setting has remained rather unsatisfactory. Perhaps this is to be expected from a "rolling" planning process that tends to favor incremental changes over the previous year's MTP, and inclusion of new (usually restricted) projects that can be more easily justified for inclusion, not because they more demonstrably meet the Institute's strategic priorities but because they are more likely to receive external (donor) support. Unfortunately, the problem appears to be systemic in the CGIAR, and the Panel does not have a simple solution for this larger issue; but still believes that there is scope for more systematic priority setting for research undertaken by WARDA.

In order to improve the priority setting process, the Panel recommends that WARDA collect relevant background information, assign appropriate weights to the constraints identified, focus only on a few major constraints of regional interest for each rice ecosystem, and better define homogeneous target areas (e.g. through stratification of the biophysical and socio-economic environments).

***Importance given to each ecosystem (upland, lowland and irrigated)***

The allocation of resources according to rice agro-ecologies in the SP is shown in Table 3.1, below.

**Table 3.3 Allocation of WARDA resources, 2003-2012, according to rice agro-ecologies**

Ecology	Area (%)	Production (%)	WARDA's R&D effort (%)
All (cross-ecology)	-	-	20
Rainfed uplands	48	29	30
Rainfed lowlands	30	36	30
Irrigated	11	26	20

Source: WARDA Strategic Plan 2003-2012, Table 2, p. 11.

The resource allocation to different rice agro-ecologies is difficult to judge, because it involves a trade-off: the largest area under rice is in the rainfed uplands where most of the rural poor live, but the lowlands (rainfed and irrigated) are where most of the potential for intensification is. Presently, WARDA is spending equal resources on the rainfed lowlands compared to the uplands. Most of the potential for intensification and production increase is in the rainfed lowland ecosystem through inland valley development and management (SC issue 3), as stated in the CCER on Integrated Genetic and Natural Resource Management. The existence of the IVC devoted to an eco-regional approach for the inland valleys shows to the Panel that WARDA is putting strong and justified emphasis on this ecosystem.

Investments on upland rice research have often been criticized in Asia and in Africa by evaluation Panels (e.g. "upland is not and will not be a major rice production ecology in West Africa in the future" or that "it has no long-term sustainability", sentences extracted from the same CCER 2006<sup>91</sup>). Such criticism has claimed that it is difficult to improve the ecosystem productivity because of the array of constraints, and that the potential for improvement will only be achieved through important changes in the production system. The constraints are undeniably strong but such statements ignore realities. Uplands are still representing a large part of the rice area (48% in Africa) and the largest farming population, and this situation is not evolving towards a reduction of upland rice importance. In Uganda, for example, the whole recent increase in rice production is through area expansion with NERICA 4 in the uplands. The level of upland rice productivity reached in Latin America, notably Brazil, is a good example of the possibility of intensification of upland rice in favorable economic and environmental conditions. NERICAs were designed and bred for the uplands, and, even if the first generation of progenies does not have yet all the requested qualities, hopes for better material are opened by the progress in the exploration of the African gene pools. Thus upland rice should be a research target in itself with adequate funding, and not just be expected to benefit from spillovers of research conducted for the other ecosystems, that would be of limited applicability anyway. Hence, on this aspect, the Panel fully agrees with WARDA's analysis.

Resource allocation to the irrigated ecosystems should also be maintained, even if it is already reaching a very high yield, and even if it may have negative environmental effects in terms of methane emission, excess water use or salinity increase that, if improperly managed (SC issue 3).

Tentative estimates show that rice is responsible for about 12% of the world's global methane emissions (IRRI, 2004, <http://www.irri.org/docs/IRRIEnvironmentalAgenda.pdf>), but most of the rainfed and irrigated rice areas are in Asia (2.6% in Africa against 93.8% in Asia). Mitigation options have been formulated by WARDA, involving water and residue management without additional cost for the rice farmers. Competition for water between agricultural and non-

<sup>91</sup> CCER on Integrated Genetic and Natural Resource Management, WARDA, Cotonou, 2006.

agricultural uses is increasing everywhere, including in Africa. The problems of water use and salinity are generally interlinked. Excessive irrigation and water logging lead to the build-up of salinity in the soil, and depletion of groundwater in river deltas can lead to seawater intrusion. Again, solutions exist or can be devised to reduce the impact of these problems. Part of the problem can be handled through local organization and policy (as done by SAED in Senegal, or Office du Niger in Mali), or through appropriate agronomical practices limiting losses such as better land leveling, crack ploughing and bund maintenance. WARDA is focusing on issues solvable by research such as the improvement of rice water use efficiency, or the evaluation of the aerobic rice production system that, besides the decrease in water use, could also help to decrease methane emissions.

The priority given to minimization of environmental impact has to be balanced against the need for an increase in food production. Ultimately, one has to remember that irrigated rice represents 11% of the rice growing area, but 26% of the production in SSA. In a situation of large importation of rice into the region, this fact cannot be ignored.

Based on the above discussion of resource allocation, and recognizing the continuing need for increased rice production and the possibilities of improving rice productivity and supply through research by WARDA—and notwithstanding the limitations of the information available on the subject—it seems to the Panel that WARDA's resource allocation for research on the different rice ecosystems is reasonably balanced (SC issue 3).

### *Programmed balance*

In the Panel's view, WARDA has to pay attention to three issues related to program balance: a) balance between applied research with immediate impact and local application, and more strategic research with medium term benefits and regional application; b) balance between disciplinary and multi-disciplinary (integrated) research; and c) balance among the various disciplines essential for rice research, notably the weight to be given to genetic or non genetic solutions to research problems.

#### *Balance between "strategic" and "applied and adaptive" research*

CGIAR Centers are expected to conduct strategic research as well as provide the link between basic and more adaptive ends of the research-development continuum. Accordingly, WARDA activities are devoted to "research for development" (R4D: a term recently popularized within the CGIAR by IITA).

In seeking this balance, WARDA seems to be getting caught between pressures to show immediate impact on rice production (coming from donors and/or governments of Member countries), and pressures (primarily) of the CGIAR SC that does not want WARDA to "replace" weak or under-funded NARS or extension systems that are all too commonplace in SSA. However, we note that the SC recognizes that the appropriate balance is difficult to establish.

WARDA documents indicate that Program 1 devotes about 60% of its resources to strategic research, and 40% to applied and adaptive research (SP 2003-2012). The validity of this ratio is difficult to assess at the institute level; but based on its detailed assessment of the research program (see Chapter 2) the Panel believes that WARDA in fact spends more than 40% of its resources to what could reasonably be considered applied and adaptive research.

In the Panel's assessment, WARDA appears to be quite efficient in product delivery; but in trying to ensure the dissemination of the technology it has developed, it occasionally seems to go too far towards the development end of the research-development spectrum. There is presently too

much focus on applying solutions to problems (i.e. on applied and adaptive research) and too little on developing new concepts and methodologies, and understanding mechanisms and processes (which can better be done through strategic research). Some of WARDA's activities seem focused on delivery systems and organizations (networks) which--though they are useful and sometimes needed, as discussed in Chapter 4 on partnerships and networks--utilize the products of research but cannot themselves be termed science. When bottlenecks in the impact pathway (such as shortage of seed) are not really scientific issues, the Panel feels it is justified to help design the means to tackle the problem (e.g. ARI) but once the mechanisms have been established, it is necessary to devise a clear exit strategy so that WARDA's continued involvement in the "downstream" dissemination activities does not use up valuable and scarce research funds.

Besides the examples discussed in the chapter on partnerships, the Panel draws particular attention to the need for balance in genetics and physiology between research on *O. sativa* or *O. glaberrima*, and NERICAs. The Panel notes that the improved performance of NERICA varieties can be due to alleles from *O. sativa*, or from *O. glaberrima* or, in the case of quantitative traits, from an optimal combination of alleles from the two sources. Hence research emphasis on NERICA alone may not yield desirable results in terms of crop improvement (see details in Chapter 2.1.); and in addition (or sometimes instead of) focusing on applied research on NERICAs, there may be much more to be gained from strategic research on *O. sativa* as well as on *O. glaberrima* (for which much less is currently known than for *O. sativa*).

The Panel recommends that WARDA allocate more time and resources to the development of concepts and methodologies, and to understanding genetic and physiological mechanisms and processes responsible for superior performance in the appropriate genetic backgrounds (*O. sativa*, *O. glaberrima*, or NERICA, according to the situation).

#### *Need for integration of research*

WARDA has utilized a program and project approach for organizing its research. The project-oriented approach is supposedly more favorable to multidisciplinary research. Though this structure undeniably facilitates exchange of views amongst members of multidisciplinary project teams, the Panel believes that WARDA does not get the best out of this choice of structure, and does not go far enough into truly integrated multidisciplinary research. Some research aspects that call for integration of various disciplines are notably absent; for instance, understanding GxE interactions in the target areas and developing ways to control them could be a common issue within and between several projects and disciplines. Another striking example is the limited interaction between breeders and social scientists in PVS approaches; the socio-economic surveys done by WARDA could serve better as possible feedback into breeding objectives (as discussed in Chapters 2 and 5).

The Panel recognizes the inherent complexity of projects that require true inter-disciplinarity, particularly the real effort needed by single discipline-oriented scientists to learn from each other and to establish common ground for discussion. This requirement--as well as the difficulty of implementing it--is illustrated by the issue raised by the SC concerning the existence of an independent drought project (SC issue 13). WARDA seems to be reproached for building a "stand-alone" project to please donors and to gain visibility in an under-researched area for addressing issues that could presumably be equally well tackled partly in an upland and partly in a lowland project. In the Panel's view, however, besides the intrinsic complexity of drought as a research issue, this project clearly needs a marked interdisciplinary approach since it must consider a large set of very diverse variables--from the very large (environment, climate, etc.) to the very narrow (genes and alleles). We believe the choice of a specific stand-alone drought-

related project was a good one, to ensure that in this project (at least) all these various aspects could indeed be well integrated. To dismantle or disaggregate this project and put its parts into two separate projects could in fact make it more difficult to undertake interdisciplinary research, and could even lead to a loss of focus on “drought”. In saying this (and in response to SC issue 13), the Panel recognizes also that there is no such a thing as a perfect structure. The best organization is the one that facilitates the work of people really motivated to work together and solve problems, so some freedom should be given to each Center to organize itself and its projects the way it prefers.

#### *Balance among the various disciplines essential for rice research*

Based on its assessment of WARDA’s research activities (see Chapter 2), the Panel believes that a better balance is needed between breeding and genetics - oriented research activities and agronomy. In Program 1, for example, there are 10.5 staff FTE for breeding/genetics against 6.9 staff FTE in agronomy (see Annex 11) which gives the staff time allocation for each discipline. Genetic improvement activities are the trademark of CGIAR Centers; and it is indeed important to have good genetic potential, but this can only be realized if crop management research is adequate. Nutrient management research has to be conducted on relevant genetic material, and this may contribute to the impression that all relevant research revolves around breeding; but, even considering this bias, our impression is that in WARDA, genetic research activities overshadow other disciplines. WARDA should seek a better balance between seeking breeding solutions and other types of solutions depending on the type of constraints being addressed. For example, WARDA has put less emphasis on crop management options for weed control when it started to work on interspecific hybrids that are supposedly weed competitive (see section 2.2 on weed management). Likewise, though the Panel commends the place given to socio-economics, it is concerned about the lack of critical mass in this area of work (see Chapter 2.4), which puts into question the satisfactory delivery of the expected outputs.

### **3.2 Quality of science**

#### *Processes in place to ensure quality*

The quality of science management can be guaranteed through a set of activities involving internal and external assessments of planned and ongoing research activities, and development of a quality assurance (QA) policy to ensure that research products meet the expected standards of quality. Many of these elements are in place at WARDA at the institution and program level (internal and external reviews) as well as at the more basic experimental level.

#### *External reviews*

One of the mechanisms to ensure research quality is to have regular reviews that could facilitate needed changes in research orientation and quality. At the institution level, this involves the EPMRs, CCERs, and donor commissioned reviews. By choice or by obligation, WARDA is regularly subjected to such evaluations; but these reviews seem to have been of uneven quality. In addition, many reviews have been undertaken during the past six years, giving the impression that WARDA has been over-evaluated during the period covered by this EPMR. The Panel analyzed all the recent reports and concluded that not all of them brought something particularly useful or original to the debate. They were often too close in time, concentrated at the end of the period under review (presumably because of the disruption created by the “Ivorian crisis”), had too broad terms of references, or made contradictory statements; and collectively, represented a heavy burden for both Center Management and scientists.

Donor commissioned project reviews cannot easily be avoided; but efforts should be made to limit the number of narrowly-focused/project reviews. *The Panel suggests that the Board-*

*commissioned CCERs be reoriented and be more forward looking; and be undertaken by experts specialized in the areas relevant to the topics covered by the review so that its results could help WARDA scientists strengthen research quality on a given topic.* Also, to improve the relevance and quality of research undertaken at WARDA, some reviews should focus not on assessment of work already done but should instead provide expert advice on what kinds of research WARDA scientists should undertake in the future. An example of such a review would be to invite a specialist on GxE interactions to help design a workplan aimed at defining target breeding environments and help prepare a project for submission to donors. The same applies to weed or water management, both of which are inadequately covered by research undertaken by WARDA.

#### *Internal assessments*

At WARDA, internal assessments are undertaken through the following instruments:

- Annual staff evaluations;
- Research Days, held in November, at which every project is subjected to review of the past year's work, and plans for the following year are scrutinized. In this one-week long exercise, NARS and other partners are invited, two members of the Program Committee of the Board attend as observer-participants, and one or two distinguished scientists are occasionally invited to lead a discussion on emerging scientific themes;
- critical discussion during the NEC meetings of the research programs' relevance for Member states of WARDA;
- in-depth review of IRS performance, eight months prior to expiry of contract;
- monitoring tours jointly conducted with NARS and other partners within the various networks; and
- Regional Rice Research Reviews (termed the 4Rs) organized every two years by ROCARIZ task forces. In this forum, external scientists are invited.

Collectively, these internal assessments, in which external inputs are also sometimes sought, cover all organizational levels--individual scientists, projects, networks--and seem to the Panel to be frequent and thorough enough.

#### *Quality assurance (QA)*

Standard Operating Procedures (SOPs), well maintained equipment facilities, quality monitoring and auditing, statistical considerations and documentation, and training in these issues are all expected to be part of a good quality assurance (QA) plan. The Panel is not aware of a formal QA plan at the institute level, but was happy to note that many elements of it were already in place (e.g., SOPs for IT use, biometric control on experimental designs, protocols for PVS trials, etc.). In the Panel's view, WARDA can only benefit from a more systematic and comprehensive collective brainstorming on these issues, organized by the ADG for Research, and this would be expected to help articulate a proper plan for quality assurance in all aspects of research. The Center's quality assurance policy is already a required field in project proposal forms for some donors, and in some other non-CGIAR institutes this requirement is very adequately satisfied by a response indicating that the Center or particular research unit meets international quality certification standards (ISO 9001 norms). In the Panel's view, it is just a matter of time before such certification could be required of all international Centers. *The Panel therefore suggests that WARDA prepare a comprehensive QA Plan for the institute, which could then potentially serve as the first step toward seeking ISO certification for the Center or one or more of its research laboratories.*

#### *Critical mass*

A small number of scientists working in many different disciplines, as is the case at WARDA, can find it difficult to undertake first class disciplinary research, which (globally) is more and more the result of team effort among collaborating scientists located elsewhere. However, it is difficult

to determine what should be the minimum critical mass for an institution such as WARDA whose program is still evolving; and of course, the staffing levels will also depend on funding or collaboration opportunities. Nevertheless, based on our assessment of the research program (see Chapter 2), we believe WARDA is currently an under-staffed institution. This is in part due to the lingering after-effects of the “Ivorian crisis” five years ago, which made it difficult to retain the most experienced people. Now that the program and management of the Institute seem to have stabilized, more efforts should be made to recruit new senior staff of international stature. Another way of dealing with the critical mass issue would be through secondment of scientists from advanced institutions working on areas of common interest.

The argument invoked by WARDA that it uses its partnerships with NARS to leverage resources and to augment its “critical mass” is valid, but only in relation to applied research. NARS have their own specific objectives that may not always fit with WARDA's. In addition, the Panel is concerned about transaction costs for such strategy: time lost in travel, time dedicated to specific needs of each individual partner, difficulties of communications etc. WARDA's scientists cannot just act as coordinators of a network of NARS scientists. They have to have their own research programs on strategic issues if they wish to maintain a good scientific program with high credibility. Having many different partners in many different countries is already taking a very large toll on the personal research activities of key scientists (e.g. some breeders) whose contributions are expected in a wide range of projects. This could have serious consequences on research quality; and the situation can only worsen with the planned expansion of WARDA's membership as an association, unless additional staff are recruited to continually match “critical mass” with critical needs.

The same word of caution applies to WARDA's continuing evolution towards the development end of the research-to-development continuum. A major risk for scientists is dissipation of energies on areas of research in which they have little comparative advantage. Instead of asking WARDA scientists to engage in development-related work, such activities, which have to have a strong local component, should be left to other organizations more suited to this task (NARS, extension agencies, NGOs, etc.).

In order to ensure that available scientific talent is utilized primarily for science, and in order not to compromise research quality, the Panel recommends that WARDA make every effort to achieve a reasonable balance between in-house scientific activities and external network or partnership activities that focus more on development than on research.

As important as the number and quality of senior scientists is the research support available to them. The Panel worries about the reduction in the number of well-trained and qualified research assistants—fewer of whom are currently engaged in research at the Cotonou site, compared with the much larger numbers that were available in M'bé, prior to the “Ivorian crisis”. The Panel was told that in some projects daily workers are currently being used for making field measurements and that the Farm Unit too was using under-trained workers for undertaking specialized operations. While additional training could compensate for lack of experience, in the Panel's view frequent turnover of such especially trained staff can be detrimental to research quality. In addition, there is potential loss of efficiency, for there can be considerable loss of time in having too frequently train new batches of research technicians and field staff. The Panel therefore urges WARDA management to find ways to ensure a high-quality stable work force in the research support functions, while of course keeping in mind the requirements of local labor laws in Benin and other countries where WARDA scientists conduct research.



## Indicators of science quality

### Publications

Scientific production is a good proxy of the quality of science. For this reason, following the SC standard methodology, the Panel analyzed the scientific production of WARDA's IRS research staff present at the time of the review over the last five years and compared this snapshot of WARDA's results with CGIAR averages. Out of the 44 IRS (including post-docs and regionally recruited staff) reported by WARDA in 2006, 29 (66%) indicated they devoted at least 25% of their time to research activities. The remaining 34% were IRS devoted almost solely to management activities, and were therefore not considered IRS researchers (IRS-R).

Over the 2000-2005 period, these IRS-R published over 400 publications (books, book chapters, communication to conferences or congresses, and journal articles), which means over 95 publications annually. Details per discipline are presented in Table 3.2 (see the full list in the Annex 12). Approximately 33% were peer-reviewed. WARDA's scientists publish slightly less peer-reviewed publications than the CGIAR average (see Table 3.3). Only 2/3 of the IRS-R published peer reviewed journal articles, which seems surprisingly low, notably when compared with the CGIAR average. The Panel suggests that the causes of this should be analyzed and the situation monitored by WARDA. Considering only the publishing scientists, the number of peer-reviewed articles per IRS-R, per year is also below the CGIAR average. However, given the two successive relocations, the abrupt departure of very experienced scientists after the "Ivorian crisis", and the loss of the long-term trials in M'bé, the Panel is of the opinion that it can be considered as satisfactory.

**Table 3.2 Number of Publications (\*) of WARDA scientists (\*\*) by Year and Research Area**

	2000	2001	2002	2003	2004	2005	2006	Overall	Average ***
Breeding and Molecular sciences (Breeding, Biotech. and Genetic Resources)	6 (4)	9 (4)	7 (4)	8 (3)	28 (6)	20 (5)	20 (5)	98 (31)	3.2
NRM / Agronomy	17 (3)	24 (5)	7 (5)	11 (3)	4 (5)	18 (5)	24 (4)	105 (30)	3.5
IPM	13 (6)	10 (3)	8 (2)	7 (2)	11 (2)	14 (2)	7 (2)	70 (19)	3.7
Partnerships/Networks/TT/ Innovation systems	3 (4)	16 (9)	11 (8)	7 (11)	1 (11)	25 (11)	13 (12)	76 (66)	1.2
Socio-Economics	4 (3)	7 (4)	7 (4)	7 (3)	5 (4)	2 (4)	9 (6)	41 (28)	1.5
Institution/Systemwide	3 (1)	6 (3)	0 (3)	1 (4)	0 (4)	5 (4)	3 (7)	18 (26)	0.7
Overall	46 (21)	72 (28)	40 (26)	41 (26)	49 (32)	84 (31)	76 (36)	408 (200)	2.0

\* Journal articles, books, book chapters and edited proceedings (including publications with NARS, according to the PM Indicators). (\*\*) in brackets: the number of internationally recruited scientists that took part in the research programs in each year. (\*\*\*)Average refers to publications per person per year for the entire period.

To assess the quality of the journal articles, the Panel, although conscious of the limits of such indices<sup>92</sup>, used journal impact factors and ranks in the discipline. The data submitted to us showed that 243 articles were published in journals between 2000 and 2006. Roughly, 58% of the papers were published in journals with impact factor (average of 20 per year, higher than the 16

<sup>92</sup> Amin M. and Mabe M., Impact factors: use and abuse. Perspectives in Publishing, 2000, 1:1-6.

recorded for the 1994-1999 period), against 42% in national or local journals without impact factors. The impact factor mode is at 1.0 and only 13.5% of the publications have an impact factor of more than 2.0. The rank of the journal in the discipline (Agriculture in most cases) is more satisfactory with 71% of the publications in journals ranking above the average of the discipline and 16% ranking in the 10% best journals of the discipline. Based on these criteria, the number of published papers per scientist appears moderate and, with the exception of a few excellent papers, the impact levels are good for the domain but not exceptional. This reflects the orientation of WARDA that, in the research-to-development continuum, tends to put the cursor closer to development activities that international journals judge too site-specific for a large audience.

**Table 3.3 Scientists' productivity for the previous five years for the IRS-R that were present in 2006: WARDA and the CGIAR (\*)**

Productivity indicator	WARDA	CGIAR Average
1. % of IRS-R that publish peer reviewed publications (books, conference proceedings and/or journal articles) (29 scientists)	86	81
2. % of IRS-R that publish peer reviewed journal articles (29 scientists)	66	83
3. Number of peer reviewed publications (books, conference proceedings and/or journal articles) per IRS-R per year (29 scientists)	1.1	1.7
4. Number of peer reviewed journal articles per IRS-R per year (29 scientists)	0.7	1.2
5. Number of peer reviewed journal articles per publishing IRS-R (19 scientists) per year	1.0	1.4
6. % of IRS-R that have received honors and prizes (29 scientists)	41	24
7. % of IRS-R that have supervised degree students (29 scientists)	55	56
8. average # of students supervised (29 scientists)	5.0	5.2

(\*) Considers only internationally recruited staff devoted to research (IRS-R)

Source: SC, based on information provided by WARDA.

Based on this analysis, *the Panel encourages scientists to publish better rather than more*: articles rather than conference proceedings, even peer-reviewed; in international journals rather than in local ones; and in English rather than in French. In the DG's New Vision, WARDA's scientists are expected to publish at least two peer reviewed journal articles per year. The Panel recognizes that this takes considerable time, and, to a certain extent, imposes to adapt research for publication. Notwithstanding the difficulties, *the Panel encourages scientists to invest more into this activity which is absolutely essential for their individual career and, globally, for the scientific reputation of the institution.*

#### *Officially released varieties*

The institutional output in terms of publications is one way to evaluate science quality but other measures of quality are also important, notably patents. For institutions strongly involved in plant breeding, officially released varieties should be considered as equivalent to patents. Table 3.4 summarizes the varieties released in West Africa during the 2000-2006 period.

**Table 3.4 Varieties adopted and/or released during the 2000-2006 period**

Rice ecology	Number of varieties adopted or released	
	NERICA	Other
Upland	18	1
Lowland	11	-
Irrigated	3	17
Others	-	-

Source: WARDA

WARDA itself does not propose varieties for release. It is NARS a role. Many "adopted" (when there is no formal release system in the country) or released varieties, however, result from regional collaboration between NARS and WARDA. It is impossible to determine precisely what respective parts NARS and WARDA played in this process, but this part is obviously very important since the NERICAs, for which WARDA played the major role in the hybridization and selection processes, represent a very large part of the released varieties. For the irrigated ecosystem, the non-NERICA varieties are either coming from WARDA *O. sativa* program (Sahel varieties) or are introductions often through INGER-Africa. WARDA's achievements in this domain are indisputable. Moreover, the figures can be considered as conservative estimates. In the past, monitoring tours organized by INGER-Africa allowed to collect information on the released varieties in the member countries participating in the network. Monitoring tours have been discontinued. Efforts are being made by WARDA to continue to collect the same information but only a couple of countries answered the most recent survey.

From the background of the released varieties, the Panel wants to draw attention to the fact that WARDA seems to be the almost exclusive provider of new varieties in Africa. This shows a worrying weakness of NARS breeding programs. The Panel was struck by the fact that ISRA in Senegal, for example, did not feel it necessary to have an irrigated rice breeder. We understand the pragmatism of ISRA but feel it is a heavy responsibility for WARDA.

#### *Place in the international research effort*

Another way to measure research quality is through the role played by WARDA scientists in the coordination of international efforts on African rice, and the rate of approval of competitive research proposals they developed. WARDA scientists are regularly associated to successful commissioned or competitive scientific projects; and the Panel, well conscious of how much time and effort this represents, congratulates scientists for the number and the quality of the projects they are involved in. This success is absolutely essential for the financial health of the Center.

#### *Awards, honors and prizes*

During the review period, several important awards were won by individual scientists or by the institution itself. Most of these were related to the development of interspecific *sativa x glaberrima* hybrids, notably the prestigious World Food Prize for Dr Monty Jones and the Koshihikari International Prize from Japan to Dr Moussa Sié. Other awards were won for the ASI thresher-cleaner and for excellence in communications. As shown in Table 3.3 the percentage of IRS-R who have received honors and prizes in the last five years is nearly twice the CGIAR average. These awards are prestigious and well deserved, and acknowledge WARDA's strong contribution to African rice research and development, notably its successes in exploiting the African rice gene pools.

### ***Global public awareness versus scientific communication***

In the modern world, research, as all other types of activities, has to justify its role and demonstrate its effectiveness. For institutions that rely only on donor funds to survive, the temptation is strong to oversell potential products and breakthroughs to donors. Breakthroughs are by definition one-time shots and it is difficult to maintain the level of interest of donors over a long period. Overselling research activities have immediate benefits in terms of donors' support that reward success stories, but it has a long term cost, which can be the loss of trust of the scientific community if research results do not back up the initial claims.

Other CGIAR Centers seem, in retrospect, to have succumbed to this temptation, perhaps inadvertently. The Panel thinks that WARDA too needs to be cautious with the NERICA story and the way it is sometimes reported, probably by excess enthusiasm. The fact that interspecific hybridization between *O. sativa* and *O. glaberrima* is now possible for any kind of parental combination is a *true scientific breakthrough* and opens broad perspectives for rice genetic improvement. However, it would be a stretch to say it "revolutionized the approach to rice breeding" since examples of successful interspecific hybridization within the *Oryza* genus are old (e.g. introgression of *Xa21*, a gene of resistance to bacterial blight from *O. longistaminata* into Asian varieties in the 70s). The 150.000 ha or so grown with NERICA in SSA (6.7% of the upland rice area) is evidence of success in dissemination but it is not yet a "Green Revolution in Rice in SSA", although it may be a step towards it. The temptation to present NERICAs as a solution to all African rice problems risks undermining truly good scientific work and real impact. The Panel understands how the NERICA story can boost rice production in Africa, and therefore rice research, and the need for it, but the Panel also feels that WARDA should pay more attention to the balance to be maintained between scientific communication and public promotion and awareness building. Depending on the audience, the message has to be adapted. For a scientific audience, it has to be backed up by solid facts. For a broad audience, the message should not be overoptimistic or raise unrealistic expectations.

### ***Concluding remarks in Relevance and Quality***

It is the Panel's view that WARDA has conducted very relevant work focusing both on genetic and non-genetic solutions to rice production systems in Africa. The achievements are many, and are in line with its mission and CGIAR systems priorities. These are dealt with in detail in Chapter 2.

WARDA has placed considerable effort on the elaboration of its SP 2003-2012. This is a positive development as it gives a framework from which MTP plans can be developed. However, the relevance and the quality of science at WARDA could greatly be improved if the current research priority setting process were improved.

There is a need for better targeting of research activities, and the Panel (Section 2.2.6) suggests a methodology for stratification. These would enable the Center to focus only on a few constraints of regional importance. Then, appropriate crop improvement and NRM management solutions could be specifically developed and disseminated to the target areas, ensuring better adoption by the farming communities. The proposed research planning could also facilitate better interdisciplinary at WARDA.

The allocation of resources should gradually favor the technology generation project activities (Program 1, currently 53%) in relation to support activities (Program 2). Resource allocation between the major rice ecologies is satisfactory, and responds to the need for intensification of the irrigated and rainfed lowlands. In relation to research-development balance, it is suggested that the Center places more emphasis on strategic rather than applied research, and identify and

strengthen strategic partners for product delivery. Moreover, a better balance between breeding and NRM research activities should be ensured and WARDA's role be better demarcated from that of NARS based on their respective missions and comparative advantages.

Very good progress has been made in the implementation of measures to ensure quality of science. Nevertheless, more can be achieved with forward looking and more specialized reviews in areas of strategic importance. The Panel believes that good progress has also been made in terms of the development of rice varieties. The publication record of WARDA is good in number and in quality, though the number of papers per scientist is below average compared to other CGIAR Centers. Finally, WARDA is understaffed in some areas of research. Steps need to be taken to improve critical mass, and to use researchers primarily for scientific rather than networking activities.

## 4 PARTNERSHIPS AND LINKAGES

WARDA's *modus operandi* is partnership at all levels. WARDA has developed highly diversified partnerships with all levels of the rice sector. All stakeholders in the countries visited commended WARDA's partnership mechanisms. Indeed, WARDA is recognized as a "partnership Center" with privileged relations with its constituency, mainly constituted by NARS. This is very important for the development and uptake of its technologies in the countries. The previous EPMP recommended a periodic review of WARDA's partnerships. The Panel benefited from a CCER on partnerships done in 2004. This was the first CCER on partnerships by WARDA and in the CGIAR system. The CCER team traveled extensively in seven WCA countries. However, this CCER also dealt with many other issues at WARDA, including research priorities and balance, research methodologies, outreach activities, variety release, registration and seed distribution, publications, etc. That review made 18 recommendations. The CCER's review panel commended WARDA for its partnership model, which it considered unique and exemplary, and which, it said, could be emulated by other Centers. This success was due largely to its "Task Forces" initiative, which was merged with the CORAF/WECARD rice network to form ROCARIZ.

### 4.1 Links with NARS and networking, including extension to ESA

The partnerships at WARDA operate mainly through networks, as vehicles to ensure relevant outputs (IPG) and to strengthen the overall innovation system. The main networks that WARDA coordinates are ROCARIZ, ECARRN, INGER, ARI, IVC and SWIHA.

#### **ROCARIZ**

ROCARIZ was formed in 2000 by merging WARDA's regional task forces with the CORAF/WECARD's rice network. This was already in progress during the fourth EPMP, and represents a saving in terms of reduced duplication of effort and increased efficiency and effectiveness. ROCARIZ has more than 150 rice scientists in WCA in 21 WARDA/CORAF countries. In the period 1996-2005, about US\$ 2.2M was disbursed as small competitive grants to researchers of ROCARIZ. Every two years, Regional Rice Research Reviews (4 Rs) are held (in 2002, 2004, 2006). At the 4 Rs, awards are given for best presentation by NARS scientists, best write-up by NARS scientists, and best contribution to rice R & D. In ROCARIZ, there is insistence on increased scientific rigor: the proceedings are since 2004 peer-reviewed, and the best articles are since 2006 published in the African Crop Science Journal.

There is also increased collaboration with universities, with only one university scientist participating in 2002, and seven in 2006. The University of Abomey-Calavi in Cotonou and the University of Lomé in Togo benefit particularly from this inclusion. WARDA operates a visiting scientist's scheme, including from universities, since 1985. The CCER on partnerships recommended enhanced partnerships between universities and WARDA.

This CCER had the following comments on strengths and weaknesses of ROCARIZ: "ROCARIZ's *strengths* include: excellent Task Force approach (which has increased team work between NARS scientists and among the NARS), assured access to WARDA's expertise, funding opportunities for the NARS, devolvement to NARS of responsibilities for implementing activities, improved NARS interests in writing for publications, a good monitoring mechanism, successful involvement of extension agents, and responsiveness to NARS needs. Its *weaknesses* include: domination of network projects by a few active NARS, poor involvement of CSOs at systems level (ARI should collaborate with ROCARIZ to alleviate this weakness), national level

partnerships are ad hoc and without clear terms of reference, poor working relationships between Task Forces, and inadequate quantity and quality of publications".

The EPMR Panel relies on this CCER assessment, and notes that recommendations were made to alleviate the weaknesses, but several of these remain, as they are hard to overcome.

ROCARIZ has, for the past five years, contributed significantly to closer and increased research collaboration between WARDA and NARS scientists and among the NARS. In addition, capacity building in the form of devolvement of responsibilities of research activities to NARS and increased capacity of NARS to generate project proposals and scientific publications are other contributions made by WARDA through ROCARIZ. The quality of publications from the NARS and the interactions between various Task Forces within ROCARIZ are yet to improve. During the period under review, publications co-authored with NARS scientists increased considerably from 2000 to 2005. The number of joint project proposals with NARS has also increased during the same period. Through ROCARIZ, WARDA is increasing its scientific capacity and attaining critical mass in areas where alone it would not be possible, as shown in Table 4.1 below.

**Table 4.1 Critical Mass through ROCARIZ Task Forces**

Task Forces	Total number of scientists mobilized	Number of projects funded					Total 2001-2005 <sup>1</sup>	Participation at 4Rs meetings		
		2006	2001-2002	2002-2003	2004	2005		2002	2004	2006
Breeding	44	26	22	11	13	72	36	12	11	
IPM	40	30	33	14	15	92	40	13	16	
NRM	22	17	26	-	8	51	16	14	16	
Economics	22	5	8	5	3	21	9	7	12	
Technology transfer <sup>2</sup>	10	-	6	11	3	20	26	8	5	
<b>Total</b>	<b>128</b>	<b>78</b>	<b>95</b>	<b>41</b>	<b>42</b>	<b>256</b>	<b>126</b>	<b>54</b>	<b>57</b>	

1 No funding available in 2006

2 Technology transfer started in 2002

Source: Achievements since the Fourth EPMR, WARDA, March 2007.

ROCARIZ supports research on mangrove-swamp rice technologies at Rokupr Research Station in Sierra Leone, as WARDA itself is not doing the research anymore on rice for that agro-ecology.

A milestone in ROCARIZ achievements, together with ECARRN, was the organization of the first African Rice Congress in Dar-es-Salaam, 31 July-4 August 2006. The presentations held at the Congress were mainly from NARS, members of ROCARIZ or ECARRN and there was a sizeable involvement of researchers from Asia, including from IRRI, and from Advanced Research Institutes. The papers presented at the Congress are on WARDA's website. The intention is to repeat the Congress every three years. The Panel commends WARDA for its role in organizing this congress.

### **ECARRN**

The Eastern and Central Africa Rice Research Network (ECARRN) was created by the Association for Strengthening Agricultural Research in Eastern & Central Africa (ASARECA) and is modeled after ROCARIZ, which operates in WCA through CORAF/WECARD. The main motivation for creating ECARRN is the rapidly increasing rice consumption in cities in ECA,

lagging rice production with imports surpassing over a million tons and the great potential for an accelerated uptake of WARDA's products and ultimately impact.

It is to be noted that WARDA's COM made a resolution (#7) at its last meeting in 2005 in Ouagadougou to encourage the expansion of WARDA's geographical mandate in accordance with WARDA's constitution. Two additional arguments explain the establishment of ECARRN. The Canada Fund for Africa made a grant to selected CGIAR Centers, including WARDA, to conduct work outside their normal prescribed mandate (West Africa in the case of WARDA). In addition, it enabled WARDA to access EU funding for rice research only available under ASARECA member countries.

ECARRN became functional in January 2005. ECARRN aims at increasing the efficiency of rice research in the ECA sub-region, to facilitate economic growth, food security and export competitiveness through productive and sustainable rice production systems. ECARRN is one of the seventeen research networks, programs and projects of ASARECA. A priority setting for ECARRN took place in 2003, and a priority-setting workshop by different stakeholders was held. The procedure followed for priority setting was that developed by ISNAR. The result of this priority setting for ECARRN was published by ASARECA in December 2005.

The fourth EPMR suggested that WARDA takes caution and informed judgment into building partnerships in ECSA. Particularly for ESA, IRRI is a natural CGIAR partner as IRRI has already shown interest in this part of Africa. JICA, SG 2000 and other NGOs and the private sector complement WARDA's efforts in this region through ARI. JICA experts are posted in Kenya and Uganda<sup>93</sup>.

WARDA hosts the ECARRN coordinator, a visiting scientist and three support staff at the IITA substation in Dar-es-Salaam. There is also a visiting scientist there. In 2005, a Memorandum of Understanding was signed with NARO of Uganda, and SG 2000. NERICA varieties are now rapidly expanding in Uganda, with 25,000-35,000 ha already being grown<sup>94</sup>.

The Panel believes that WARDA is not over committing resources in this modest expansion, which follows WARDA's partnership and networking mode of collaboration and which is fully demand driven. In addition, ASARECA is pleased with the collaboration with WARDA and points out that the ECARRN network operates according to ASARECA's *modus operandi*.

However, ASARECA is being restructured, WARDA will need to take over ECARRN at the end of its existence as an ASARECA network, planned for September 2007. When the network comes under WARDA's sole leadership, the challenge will be very great because the expectations are now very high and the countries are many.

In light of requests from Central and Eastern African countries to join the Association, and the COM resolution regarding the expansion of its geographical mandate, *the Panel recommends that WARDA develop a medium and long-term strategy for a phased expansion in Central, East and southern Africa, in line with available funds, without compromising critical mass in West Africa. Moreover, the programmatic alignment of WARDA with IRRI in East and southern Africa should specify their respective roles based on their respective comparative advantages.*

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<sup>93</sup> The R.D. Congo, Gabon and the Central African Republic have made a formal request to COM to join the Association. Congo (Brazzaville), Ethiopia, Tanzania and Uganda are also expected to make a request.

<sup>94</sup> See also: Kijimo, Yoko, Dick Sserunkuuma and Keijiro Otsuka, "How Revolutionary is the "NERICA Revolution?" Evidence from Uganda, *The Developing Economies*, XLIV-2, June 2006, 252-67.



On the SC issue on whether WARDA has the critical mass to extend reach of activities into ESA, and on what will be the opportunity cost to research for the WCA region, WARDA has been cautious in expanding into ESA, as outlined above. Because of this modest expansion, no research activities were closed or diminished for the WCA region as the main objective of the expansion is to enable ESA benefit from the research and technologies already developed at WARDA.

### *INGER-Africa*

This has already been discussed under 2.1.section on rice genetic improvement.

### *ARI (African Rice Initiative)*

ARI was the outcome of the heads of state meeting held in Yamoussoukro (Côte d'Ivoire) in March 2002 (preceded by a COM at M'bé) to alleviate the "quality seed crisis" with respect to the diffusion of NERICAs. WARDA hosts the ARI coordinator and an assistant, has the secretariat (supported by Rockefeller Foundation, USAID, UNDP, Japan), and convenes ARI meetings but operates mainly through the member countries. JICA of Japan seconded a breeder, seed specialist and agronomist to ARI and there is also a U.N. volunteer. ARI covers all of SSA and maintains a presence in each participating country through a stakeholder platform.

ARI is a broker between research institutions and extension services and is now the primary vehicle of dissemination of WARDA products, including new NERICA lines, fertilizer rates, weeding regimes, sowing depth and date of sowing, NERICA based recipes. ARI really took off in 2005 with an AfDB loan of US\$ 38M to 7 pilot countries in WA. 2,800 tons of seed are now being produced in these countries through ARI. Presently, 100 tons of NERICA 1 & 2 foundation seed are being produced at M'bé, Côte d'Ivoire on the request of the Nigerian government. Special attention was given to the post-conflict countries to help them in their rice sector rehabilitation efforts. ARI is strongly linking up with NGOs (e.g. Songhai in Benin), with links to the private sector being more recently explored.

Since its inception in 2002, the following main achievements have been recorded: the Coordination Unit of ARI, which the Panel commends, constantly addresses seed availability. Table 4.2 provides a summary of foundation seed produced and distributed to several countries through ARI.

**Table 4.2 Production and distribution of NERICA Foundation Seed by ARI Coordination Unit**

Year	Seed produced (kg)			Seed distributed (kg)			Beneficiary countries
	B.S. <sup>1</sup>	F.S. <sup>1</sup>	Total	B.S.	F.S.	Total	
2003	75	350	425	65	350	415	Mali, Togo
2004	151	1,063	1,214	100	1,000	1,100	B. F., Mali, Togo, Nigeria
2005/2006	1,474	14,102	15,576	1,400	13,900	15,300	Benin, Burkina Faso, Democratic Republic of Congo, Ethiopia, Gambia, Ghana, Guinea, Nigeria, Mozambique, Philippines, Sierra Leone, Tanzania, Togo, Uganda
Cumulative total	1,700	15,515	17,215	1,565	15,250	16,815	

<sup>1</sup> B.S: Breeder Seed, F.S: Foundation Seed

Source: Achievements since the Fourth EPMR, WARDA, March 2007.

In order to increase adoption rate and boost production, ARI facilitated the introduction of more than 400 NERICA lines to farmers through PVS. By the end of 2005, 11 new NERICAs were named, from which three have been released. The newly named materials are mainly extra-early (e.g. NERICA 8, 9, etc.).

ARI activities were initially restricted to pilot countries, but have been extended progressively to more countries. By 2005, NERICA lines had been tested in nearly all SSA countries. Thirteen NERICA lines have been adopted/released in 13 countries (Table 4.3), the number of varieties per country ranging from one to seven.

**Table 4.3 NERICA upland lines adopted/released in selected countries**

Country	NERICA																	Total
	1	2	3	4	5	6	7	8	10	11	12	13	14	15	17	18		
Benin	x	x																2
Burkina Faso											x	x		x	x	x		5
Congo									x									1
DR Congo				x		x	x											3
Côte d'Ivoire	x	x	x	x	x													5
Ethiopia	x			x		x												3
Gambia	x	x	x	x	x	x	x											7
Ghana	x																	1
Guinea	x	x	x	x	x	x	x											7
Kenya										x								1
Mali				x				x					x					3
Nigeria	x	x	x															3
Sierra Leone	x	x	x	x	x	x												6
Togo	x		x	x														3
Uganda				x														1
<b>Total</b>	<b>9</b>	<b>6</b>	<b>6</b>	<b>9</b>	<b>4</b>	<b>5</b>	<b>3</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>

Source: Achievements since the Fourth EPMR, WARDA, March 2007.

The CCER on partnerships had the following assessment of ARI: "ARI's *strengths* are that: it covers the whole of SSA, has a presence in each member country through a stakeholder platform, has facilitated closer collaboration between extension and research in NARES, employs and reinforces PVS-R&E and CBSS, and goes beyond production and development to processing and marketing (adding value). The only *weakness* identified by partners is that ARI focuses only on NERICAs, thus limiting its domain to the upland rice ecology."

In the meantime, WARDA has developed 60 lowland NERICA varieties and focuses on the lowlands (including the inland valleys) because of their great potential for production intensification. Five lowland NERICA varieties have now been released and are expected to be promoted by ARI.

The SC states that availability of good quality seed is a bottleneck in taking the fruits of WARDA's research to farmers. How effectively is WARDA collaborating with NGOs, farmer organizations and the private sector to promote the development of 'seed systems' designed to enhance the delivery of promising NERICA lines? The issue of seed quality and availability has been a subject of major focus at WARDA during the past five years, and the issue remains. A second workshop on PVS and PPB was held at WARDA in November 2006 and critically reviewed these issues through a special working group. Recommendations on how to address

seed quality were made. In addition, WARDA's 2003-2012 SP outlined the creation of a private seed company (WARDA, Inc)<sup>95</sup>. In general, the private sector for rice is not strongly developed in West Africa; a private entrepreneur from Benin has begun collaborative initiatives with WARDA to start creating farmer seed enterprises.

Seed availability is an issue. Strong efforts are being made by WARDA to remove this bottleneck to varietal diffusion, notably through ARI. As long as seed production does not deprive research of its limited critical mass and resources, it is commendable. The Panel would like to stress that the constraint, which does certainly apply to NERICAs, is also affecting the *sativa* advanced lines and that the benefits of large scale seed multiplication should not be reserved to NERICAs only. The full title of the ARI network implies that other varieties can be included but the tables shown to the Panel only presented NERICAs and no mention was made of the respective shares of the two types of material.

While seed systems are weak in West Africa, the Panel believes that a long-term solution should involve the development of seed systems whereby the private sector is a partner. Therefore, WARDA should undertake within ARI some activities aimed at strengthening of existing institutions in the seed sector and promoting the establishment of new ones.

The Panel welcomes the ARI initiative; but it is too early to make an informed judgment on the efficiency and effectiveness of the initiative. WARDA should be cautious in defining its future role in ARI, which should emphasize training and capacity building on seed systems.

#### *IVC*

The Inland Valley Consortium (IVC) has been hosted by WARDA since its inception in 1993. The IVC is comprised of 12 countries in West Africa. It operates through partners (national coordination units in member countries) and a coordinating unit managed by a Regional coordinator housed in WARDA. Phase I of IVC ended in 1999, whilst phase II ended in 2004. Phase III is ongoing. A Consortium Steering Committee (CSC), reporting to WARDA, meets annually. Its role is to propose directions for scientific strategy and partnership; follow-up and evaluate the overall functioning of the Consortium; amend and adopt the proposed budget of RCU; and evaluate and then select the projects for funding by the Consortium.

The main IVC goal is to foster the production potential of the inland valleys in SSA through the adoption of sustainable technologies and in doing so to improve the livelihood of the rural communities. More information and assessment on soil and water management research conducted in the framework of IVC are in the chapter on rice agronomy and NRM (2.3.1.1 – rainfed uplands and lowlands).

IVC is recognized as the regional NRM platform and has stimulated the financing of large inland valley development projects in Ghana (by AfDB) and in Togo (by UNDP). IVC benefited from long-term funding from The Netherlands (DGIS: 1993-2006), now stopped and being renegotiated. Funding for 2007 is ensured from the World Bank and new funding opportunities are being explored.

WARDA funded projects in IVC are:

- Inland Valley Information Systems (WAIVIS and NIVISA);

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<sup>95</sup> The setting up of WARDA, Inc. was discussed during the BOT meeting of March 2007 and no further action is taken at this time.

- Weed competitiveness of lowland NERICAs in inland valleys (confirming NERICAs superior performance); and
- Curriculum development of PLAR (technical manual).

Externally donor funded projects in the framework of IVC are:

- Sustainable Productivity Increase of Rice in Inland Valleys of West Africa (SPIRIVWA);
- Lowland Development Trajectories Project;
- Community-based Fish Culture in Irrigated Systems and Seasonal Floodplains (with IFPRI and WorldFish); and
- Promoting Ant-based Pest Control in Tree Crops in West Africa (to reduce pesticide runoff in inland valleys).

A CCER was conducted in 2004 on Phase 2 to gauge the usefulness and contribution of this systemwide program (since 1993). The following constitutes the major highlights of the IVC during the review period: The Systemwide program of IVC released WAIVIS (West African Inland Valley Information System) for the first time, available on CD-ROM and via the Web. This software draws upon the data and knowledge accumulated during 10 years of inland valley research. Apart from scientists in national programs, international organizations like IWMI and FAO are using WAIVIS. This led to joint project proposals. WAIVIS has been fully adopted by the NARI of The Gambia to store its data for inland valley characterization. National databases have been developed in Benin, Burkina Faso, Togo, and Guinea, and have recently started in Mali. National scientists are trained by WARDA GIS staff in the structure and creation of a national database based on a new format called National Inland Valley Information Systems of Africa (NIVISA). NIVISA is a relational database, which permits analyses between countries. Nigeria and The Gambia have indicated that they are discussing similar requests.

FAO, IITA, IWMI, ILRI, IFPRI, WorldFish, CIRAD, and AVRDC have joined the consortium as have three universities (ITC, WUR, Bonn). Twenty-five NARES, 21 universities, 17 government institutes, 9 NGOs, 5 farmer organizations, 4 private sector operators and 2 SROs are the regional stakeholders. The recommendations of the CCER were mainly addressed to the Regional Coordinating Unit (RCU), to WARDA, on financial matters and on the research activities of the consortium. Nearly all of the recommendations were implemented and the CCER is a good example of stocktaking and evaluation before embarking on a next Phase. It was regretted that CORAF/WECARD did not participate during Phase II; they now joined Phase III. In addition, constraints related to water management received too little attention in IVC and are crucial to IVC development<sup>96</sup>. This is still the case now although WARDA intends to recruit expertise in water management.

The IVC is a flagship SWEP coordinated by WARDA with many partners in WCA and in the North that provides the NRM research so vital to the lowland agro-ecology development, which has great rice intensification potential, and for which adapted NERICA varieties are now available. The Panel assesses IVC as a crucial SWEP in WARDA's research program, particularly for NRM in the lowlands. There have been some recent financing problems in IVC and the Panel hopes that these will be resolved satisfactorily. Section 6.9.8 deals further with the financial problems encountered by IVC.

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<sup>96</sup> The following publications are available:

- Manuel technique d'aménagements de bas-fonds riziocoles au Burkina Faso. 2006, 49 p. + annexes
- FAO and WARDA, 2005. FAO-WARDA Workshop on Integrated Irrigation Aquaculture, Bamako, Mali, 4-7 November 2003, FAO, Rome, 44 p.
- FAO and WARDA, 2006. Integrated irrigation and aquaculture in West Africa: concepts, practices and potential, FAO, Rome, 181 p.

## **SWIHA**

HIV/AIDS affects the context of CGIAR Centers' work and the Centers cannot ignore the pandemic if they want to reach their goals. SWIHA is the CGIAR Systemwide Initiative on HIV/AIDS and Agriculture. It is organized by the CDC as decided at ICW 2000. The goal of SWIHA is to safeguard and enhance human and agro-ecosystem capacity to produce food, goods and services and sustain livelihoods in the face of HIV/AIDS. The purpose is to mitigate and prevent the negative impact of HIV/AIDS on food security network resources management, poverty and human suffering. Infections continue growing and 63% of people living with HIV/AIDS are in SSA (UNAIDS, 2006). WARDA hosts the secretariat and a coordinator and serves as the convening Center.

SWIHA research produces the following IPGs:

- innovation/knowledge about the linkages between HIV/AIDS and agriculture;
- training manual and modules to be used by health and development workers;
- strategies for improving health and for mainstreaming HIV/AIDS in agriculture and rural development;
- HIV/AIDS communication strategies; and
- policy recommendations/documents.

These IPGs are obtained through various research endeavors, workshops and/or symposia with national and international participation. WARDA conducted a community vulnerability assessment in Côte d'Ivoire and did a needs assessment study in Nigeria. The effect of HIV/AIDS on household assets in Benin was studied. A regional workshop was organized in 2005 and a regional strategy for SSA was developed.

The Meta-Review of CGIAR SWEPS in 2006 noted that there is no evidence of value added to SWIHA through inter-Center collaboration to maximize CGIAR Centers' comparative advantage. IFPRI operates a HIV/AIDS program outside the purview of SWIHA. SWIHA has not been subject to a CCER, there is no formalized M&E process. SWIHA has achieved only limited success to date as a SWEP in achieving its goal and meeting its priorities, given that it has been operational for six years. Its success has largely been derived from its position as a component of WARDA's regional program and this is more apparent from activities that are more recent in the 2005-2006 period, including the establishment of ANEHA as a modality for program delivery across SSA.

The Panel, while recognizing the importance of HIV/AIDS in SSA and its effects on the farming population and the role of improved nutrition in mitigation efforts, does not understand why WARDA needs to take the lead in this commendable effort. WARDA is the smallest of all CGIAR Centers with a stagnant budget in real terms over the last five years. WARDA does not have a comparative advantage in taking the lead in this effort, which is very much about sensitization, awareness, and social science research and impact assessment; and there are no synergies with its research program. *Because the System Wide Initiative on HIV/AIDS (SWIHA) is not expected to contribute to WARDA's core research outputs, the Panel recommends that WARDA transfer its convening role to a partner more suited to leading the SWIHA initiative.*

## **4.2 Links with other CGIAR Centers and Challenge Programs**

WARDA collaborates closely with IITA in plant protection, since most of IITA's researchers in this area are based in Cotonou, e.g. on insect pests of rice in Africa. Many of these pests also occur on maize, such as stem borers, and storage insects. IITA's biodiversity (insects) resource centre is

in Cotonou and a mass insect rearing facility is in Cotonou. There is also collaboration in impact assessment. Collaboration with other CGIAR Centers occurs mainly through the networks such as IVC and SWIHA.

Regarding the Challenge Programs (CP), the GCP is discussed under genetic improvement. Idem for the Harvest Plus CP. For the SSA-CP, WARDA represents the CGIAR on the Steering Committee. WARDA participated in the competitive bidding for the Kano-Katsina-Maradi pilot side but did not prevail.

In the CP Water and Food, WARDA coordinates the African site. The Community-based Fish Culture in Irrigated Systems and Seasonal Floodplains (CBFC) project is implemented in five countries: four in Asia and one in Africa. WorldFish coordinates the Asian sites, WARDA the African in Mali, with IER – Mopti in charge. There is the possibility for a second African site in Senegal, which will probably start in 2008. The project started with an inception workshop in June 2005 in Penang, Malaysia. The kickoff was rather slow, which may be due to a frequent change of coordinators in Penang. Activities accomplished so far are: questionnaires were developed and unified across sites, and translated and tested in Mali; a relational database was developed at WorldFish allowing for cross country analyses; the database was translated by WARDA into French and tested in Mali; two villages were selected in Mali; a detailed livelihood baseline study was completed in both villages; and frequent household surveys started in both villages and integrated rice – fish culture interventions started in one of the villages.

As part of the alignment process, WARDA is collaborating closely with IITA, and will soon be responsible for providing the corporate services at the Cotonou site. The alignment process with IITA concerns: governance: with two shared Board members; corporate services; programs, resulting in a common regional MTP for WCA. The details of governance and corporate services alignment are discussed in chapter 6.

At the same time, programmatic alignment and closer collaboration is planned with IRRI and CIAT. At WARDA's last BOT meeting, three IRRI BOT members were present, including the chair and vice-chair and a member from SSA. They presented ideas and areas where synergy from collaboration would be significant. It is to be noted that at the first African Rice Congress in 2006 in Dar-es-Salaam, presence and presentations from IRRI and CIAT researchers were prominent and well appreciated.

WARDA-IRRI-CIAT collaboration will be focused on the following areas: genetic resources/seed strategies, biotechnology, genomics, MAS, post-harvest technologies, value chain development, policies, training and enhanced information sharing. A joint project financed by the Gatsby Foundation concerns the collection of local landraces of rice in Uganda, Kenya, Tanzania and Mozambique. Another activity funded by IFAD is a Program for alleviating Rural Poverty through Improving Rice production in ESA. It is proposed to establish a SSA Rice Consortium (SARC) to consolidate technology development and dissemination, conduct trainings, increase partners' involvement in technology development and dissemination, constitute a strong post-harvest technology working group by appointing an Africa-wide expert and enhance information sharing and develop an African Rice Knowledge bank (in English and French).

Canada (CIDA) has given CAD 300,000 for a conference/workshop, held in June 2007, and follow-up to develop a comprehensive strategy for programmatic collaboration and for developing joint research proposals.

On the WARDA-IRRI collaboration and the question of competing interests, WARDA and IRRI are not competing, but are instead now forging alliances. An IRRI breeder is already posted at WARDA in WCA. Similarly, IRRI-WARDA-CIAT are developing a strategic alliance in which each Center's comparative advantage will be taken into account. These comparative advantages based on ecological geography and expertise in particular environments, constraints and rice types are complementary. Integration is planned across genebanks that hold crops in common. Activities to be included in Center MTPs include joint development of an information system integrating the rice genetic resources of IRRI, WARDA and CIAT, and a global system of germplasm exchange based on INGER is proposed among other planned joint proposals and joint positions. A workshop was held in June 2007 to map out a strategic alliance to ensure that the Centers work effectively to produce synergy, economies of scale and sharing of scientific expertise. A lot of collaboration is already happening through the IHP project, GCP, and the posting of an IRRI breeder at WARDA. WARDA has developed a MOU with IRRI and with ASARECA for the establishment of ECARRN hosted by WARDA. IRRI has already placed a production specialist in Maputo, Mozambique who is IRRI Regional representative for the ESA region and program leader for IRRI's program 3. He is already conducting trials in crop management and crop protection. The future plans of IRRI include the expansion of the program to ESA countries. *The Panel strongly encourages the WARDA-IRRI-CIAT programmatic alignment in the specified areas.*

The SC issue whether in its partnership with IRRI WARDA is capturing the "non-African" specific products and knowledge for the improvement of upland, rainfed and irrigated rice, especially since this is critical for such constraints as drought and nutritional enhancement, which are generic to all continents? Issues regarding drought and nutritional enhancement are covered in detail in the genetic improvement section. The partnership with IRRI and CIAT is being strengthened as outlined before. Germplasm exchange, including through INGER-Africa, has been actively carried out between WARDA, IRRI and CIAT, especially for interspecific materials. IRRI's aerobic rice varieties comprise an important part of the materials for research of one Japanese post-doctoral fellow at WARDA, who is seeking high-yield varieties and plant types for the rainfed ecology in WCA. Another post-doctoral fellow is working within the Rockefeller-funded drought project at WARDA using both aerobic and upland rice varieties from IRRI, among other varieties, in this trials and crosses with the aim of identifying drought QTLs and producing drought-tolerant breeding lines. Unfortunately, everything tends to be branded "NERICA" at WARDA, even if only *O. sativa* products are involved. Thus, there is more to the collaboration with IRRI regarding the use of its germplasm (capturing "non-African" specific products) than one tends to see at WARDA.

On the SC issue whether in the partnership with AVRDC and others for diversifying rice-based production systems with livestock, fish and vegetables, is the work carefully focused, so that it does not dilute WARDA's efforts, and is it supported by appropriate socioeconomic research? Does WARDA have a clear rationale for its involvement in the diversification and move in this direction? The rationale behind WARDA's collaboration with AVRDC is derived from the fact that diversification in rice-based systems through high-value vegetables can improve farmers' income and increase their ability to respond to market demand. Insertion of vegetables in irrigated rice systems can stop the decrease in agricultural productivity affecting such irrigated rice schemes and increase their economical performance. Moreover, vegetables were rated by CORAF for the Sahelian environment as the most important crop, just before rice. Nevertheless, WARDA needs to move cautiously in its partnership with AVRDC to diversify the rice-based systems in order not to lose focus on its core competence in rice research. Regarding livestock and fish, caution has also to be applied because they involve different production systems. There

is an externally funded project on community-based fish culture in irrigated systems and seasonal floodplains with IFPRI and WorldFish in the framework of IVC.

WARDA and AVRDC forged an alliance with a joint MOU and have addressed research issues in rice-vegetable systems since 1992. Active work has been carried out, with AVRDC posting a scientist at WARDA when the main collaborative project was initiated in 2003. With the “Ivorian crisis”, the collaboration was somewhat affected. However, the director-generals of AVRDC and WARDA have agreed to enhance the collaboration. AVRDC plans to post a vegetable agronomist at WARDA, for active involvement in both the Global Horticultural Initiative and the new Challenge Program on Fruit and Vegetables. The use of nutritious vegetables from rice-vegetable systems can be of great value to poor populations and those nutritionally affected by diseases such as HIV/AIDS.

#### **4.3 Links with Advanced Research Institutes**

WARDA has many links with advanced research institutes, particularly in genetics, breeding and biotechnology (Cornell University, IRD, John Innes, Nihon University, JIRCAS, CIRAD, University of Tokyo, University of Kyoto, University of Montpellier, YAAS, JICA) and NRM (mainly through the IVC: ITC, WUR, Bonn, CIRAD). In molecular breeding in particular, there is strong collaboration with IRD, Cornell, IRD/CIAT, NIAS, particularly through the research consortium for drought of rice. All these partners were present at the first African Rice Congress in 2006 and made presentations. It is also expected that through closer collaboration with IRRI and CIAT, more links can be developed with their Advanced Research Institute partners. In order to gain better insights in existing seed systems, collaboration is planned in anthropology with WUR (for Guinea and Sierra Leone), in sociology with Cornell (Ghana and Sierra Leone) and in innovation systems approach with the United Nations University (Benin and Guinea). Areas where more collaboration with Advanced Research Institute partners is desirable are water management, soil fertility and agronomy, weed science, mechanization, crop physiology, modeling, spatial analysis and rice policy analysis.

The Panel commends WARDA for its long lasting collaboration with Advanced Research Institutes and encourages them to further enhance its links on rice research in Africa and in this way gain more strength and critical mass. Attendance at International Conferences and meetings, joint research programs and publications, sabbaticals at WARDA, visiting scientists and other tools for stronger and deeper collaboration need to be facilitated. A specific budget needs to be made available for developing such enhanced collaboration.

#### **4.4 Links with NGOs, civil society and the private sector (seed partnerships)**

WARDA is very keen on developing partnerships at all levels with CSOs (Civil Society Organizations, including NGOs, farmer associations, private sector operators, etc.). WARDA, as an association of Member states, cultivates ownership locally. During field visits, we were impressed by WARDA’s good links with CSOs.

The methodologies elaborated or adopted by WARDA favor participation of local groups such as PVS, CBSS, PLAR-ICM. In most cases, WARDA works with local NGOs and farmer groups on an informal basis. A formal agreement is usually only made for seed production under contract. The PADS project (Participatory Adaptation and Diffusion of technologies for rice-based Systems) financed by IFAD is now in its second phase in The Gambia, Guinea, Ghana and Mali. Through participatory field experimentation, demonstrations and a seed multiplication program, the PADS project has brought thousands of farmers into contact with WARDA's NERICA for use in



low-input rainfed systems. The PADS project has also focused on post-harvest issues, including improved paddy and seed storage and processing. The project uses the PLAR methodology. PLAR has enabled the possibility of a Rural Knowledge Center where the interested farmers can be trained as facilitators and can (partly) take over the role of the governmental (or NGO) facilitators.

NGOs with whom WARDA collaborates are ADAF-Galle in Mali, SG 2000 Mali, SG 2000 Guinea, SG 2000 Uganda, Doubei International in Côte d'Ivoire, COPRORIZ farmers' union in Bouaké, Côte d'Ivoire, ACOPCI in Côte d'Ivoire, and OVDL in Côte d'Ivoire. An agreement was signed between WARDA and Sasakawa Global 2000 for collaborative work in Africa. In Benin, an agreement was signed with Songhai, a local farm and NGO.

#### **4.5 Conclusions**

A CCER on partnerships was conducted in 2004. It commended WARDA's partnership model and recognized that a key WARDA strength lies in its partnerships and the ability to work closely with national programs, NGOs and farmers from priority setting to implementation of programs and projects. The outcomes of the partnerships are unquestionably positive. In its various partnerships and linkages, WARDA often operates as a facilitator, a broker, a service provider, an advocate, even as a trusted friend. WARDA is special and unique in the CGIAR because of the ownership partners have in WARDA. This became very clear through the CCER's and in the field visits. "*WARDA, that is us*" typifies this special relationship. In addition, on the many questions regarding critical mass, which the Panel asked WARDA staff, responses invariably included NARS scientists through the various partnerships and networks.

Nevertheless, partnerships come at a cost and sometimes transaction costs are high. It depends very much on the strength of the partners, the financing available and the prevailing policy framework. However, clearly, partners look at WARDA for scientific leadership, science quality and strategic leadership besides the products of research in terms of genetic resources, agronomic recommendations, research protocols, publications and capacity building. This is where the programmatic alignment with IITA in WCA and with IRRI and CIAT in rice research comes in. It can mean a boost in the catalytic role, which WARDA is playing in the region. WARDA's specific role in the partnerships undoubtedly has to move upstream – more strategic research, more good science, and capacity building – while the various partners adapt and tailor the technologies and approaches to the local conditions and circumstances. At the same time, WARDA needs to learn more from the partners, from field experiences and the downstream G X E interactions, and use this feedback more intelligently in its own research. Overall, WARDA embraces and values its networks and partnerships very much, and this is to be commended. "Partnerships at all levels" is a WARDA saying; and it is not an empty phrase.

## 5 ADOPTION AND IMPACT

A first issue to clarify is the definition of “adoption”. From what we understood, adoption is defined by the willingness of a farmer to test a new accession, but it seems important to see how long the variety is grown in the farmer's fields. If the new variety is tested for one season and discarded after that, one can hardly call that adoption. The number of years the variety is grown as well as the variation in surface under rice should be monitored.

WARDA conducts three types of adoption studies: adoption of modern rice varieties, yield impact studies and socio-economic impact studies on the effects of adoption. In all the kinds of studies WARDA takes a “snapshot approach”, i.e. adoption is assessed at a fixed point in time, and as declared by farmers. Yield stability over time of modern varieties and better agronomic practices are not studied. In addition, the effects of paddy rice prices paid to farmers are not considered as a factor of adoption in the studies.

### 5.1 A new methodology for adoption studies

Adoption studies conducted at WARDA provide estimates of potential and actual NERICA adoption rates and their socio-economic determinants using a new methodology<sup>97</sup> based on the “counterfactual outcomes framework”. It enables one to assess the intrinsic merit of a new technology in terms of its potential demand by the target population separated from issues related to dissemination and access to the technology (which are usually beyond the realm of research). This methodology is called “Average Treatment Effect Estimation of Adoption (ATE)”. A software tool that implements the new methodology in Stata has also been developed. Notwithstanding the deficiencies in adoption studies mentioned above, the Panel commends WARDA for this new methodology.

WARDA in 2001-2002 conducted a major study of the economic impact of improved rice varieties from both national and international research Centers on all West African rice ecologies. The study estimated that genetic enhancement and transfer has increased the value of rice production by US\$ 93 per hectare.<sup>98</sup> The study also confirmed that while irrigated and rainfed lowland ecologies have largely benefited from varietal improvements, upland rice-farming systems stayed behind due to much lower rate of adoption and the limited gain in yield. Results from more recent surveys (2003) conducted by WARDA confirm the very low uptake of modern varieties in upland ecologies due to their very low diffusion. IRRI found similar results in some of the poor upland rice ecologies in Asia.

It is to be noted that the Meta-analysis of the CGIAR impact of crop genetic research (2005) resulted in a present value estimate of total potential benefits of 321 million US\$ for rice for WARDA and its NARS partners<sup>99</sup>.

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<sup>97</sup> The paper entitled “Taking a New look at Empirical Models of Adoption: Average Treatment Effect Estimation of Adoption Rate and its Determinants” contains all the technical details of the new methodology, including (a) the formal demonstration (i.e. mathematical proofs) of the statistical properties of the new estimators of adoption, (b) the reasons why the classical adoption model yields biased and inconsistent estimates of adoption rates and extremely small and statistically insignificant estimates of socio-economic determinants of adoption; and (c) a side by side comparison of empirical results (using the NERICA data) obtained from the new methodology and from the classical model.

<sup>98</sup> Dalton, Timothy J. and Robert G. Guei, 2003. “Productivity Gains from Rice Genetic Enhancements in West Africa: Countries and Ecologies”. *World Development* 30, No 2, pp. 359-374.

<sup>99</sup> See also: “Crop variety improvement and its effect on productivity The impact of international agricultural research”, edited by R.E.Evenson and D.Gollin, CABI Publishing, 2003.

## 5.2 Adoption and impact studies

WARDA, in collaboration with the national partners, is conducting adoption and impact studies using a common methodology in nine countries of West Africa, namely Benin, Côte d'Ivoire, The Gambia, Ghana, Guinea, Mali, Nigeria, Sierra Leone and Togo. Three of these nine studies have been completed<sup>100</sup>. Datasets have been developed for the concerned countries and papers presented at international conferences or are being published. Table 5.1 below, summarizes the major findings in the three countries where the studies have now been either fully or partially completed.

In Côte d'Ivoire, a low diffusion rate (9%) limited the adoption of the NERICA lines to just 4% of the farmers in the sample in 2000. However, the adoption rate in the population could have been up to 23% if the whole population had been exposed to the NERICAs. The rate of NERICA diffusion was 40% in Guinea—much higher than in Côte d'Ivoire. The NERICA population potential adoption rate (had all the farmers in Guinea been exposed to the NERICA) is 59%, double the actual adoption rate observed in the sample (23%). Up to 53% of farmers with exposure to NERICA lines had adopted them in 2001. In Benin, the NERICA diffusion rate in 2004 was 26%. NERICA lines were adopted by 18% of the farmers in the 2004 sample, an adoption rate three times lower than the estimated potential adoption rate of 57%. Up to 70% of farmers, who were exposed to NERICA lines in Benin in 2004, have adopted them.

**Table 5.1 Summary results of the adoption and impact studies in three countries**

Category	Benin (Centre)	Cote d'Ivoire (4 regions)	Guinea (whole country)
Average adoption rate of NERICA by farmers in sample (year)	18% (2004)	4% (2000)	23% (2001)
Average adoption rate, had all farmers been exposed to NERICA (year)	50% (2004)	27% (2000)	58%
% of farmers adopting after being exposed to NERICA (year)	68% (2004)	38% (2000)	53% (2001)
NERICA diffusion rate - % exposed to NERICA (year)	26% (2004)	9% (2000)	39% (2001)
Estimated area under NERICA (year)	1995 ha (2003)	-	51,000 ha (2003)
Average NERICA yield impact for all farmers (year)	1,587 kg/ha (2003)	276* kg/ha (2000)	.085* kg/ha (2003)
Average NERICA yield impact for female farmers (year)	850 kg/ha (2004)	741 kg/ha (2000)	
Average NERICA yield impact for male farmers (year)	517 kg/ha (2004)	-134* kg/ha (2000)	
Impact on per capita rice income per year	CFA 14,100 (2003)	-	-

\*Not statistically different from zero at the 5% level - Source: Achievements since the Fourth EPMR, WARDA, March 2007.

<sup>100</sup> Diagne Aliou, 2007, "Bred for Women Rice Farmers? Impact of NERICA Adoption on Rice Yield in Côte d'Ivoire", in revision for Experimental Agriculture.

Agboh-Noameshie, A.R., F.M. Kinkingninhoun-Medagbe and A. Diagne, 2007, "Gendered impact of NERICA adoption on farmers' production and income in central Bénin", Contributed paper accepted for presentation at the Second Conference of the African Association of Agricultural Economists, August 20-22, 2007, Accra, Ghana.

Adegbola Patrice, Y. Aminou Arouna, Aliou Diagne and Souléïmane A. Adekambi, 2006, "Evaluation de l'impact économique des nouvelles variétés de riz NERICA au Bénin: Evidence avec les modèles basés sur l'approche contre factual". Paper presented at the First African Rice Congress, Dar es Saaam, Tanzania, July 31-August 4, 2006.

Diagne Aliou, Marie-Josée Sogbossi, Sekou Diawara, Abdoulaye Sadio Diallo et Alpha Bacar Barry, 2006, Evaluation de la diffusion et de l'adoption des variétés de riz NERICA en Guinée, Contributed paper accepted for presentation at the second Conference of the African Association of Agricultural Economists, August 20-22, 2007, Accra, Ghana.

### 5.3 Determinants of adoption

The results of the analysis of the socio-economic determinants of NERICA adoption in Côte d'Ivoire (2003) in four regions, including uplands and lowlands, show that the main factors affecting the adoption of NERICA were: growing rice partially for sale (positive impact), household size (positive), age (negative impact), having a secondary occupation (negative impact), growing upland rice (positive impact), past participation in PVS trials (positive impact) and living in a PVS-hosting village (positive impact). In Guinea, the main socio-economic determinants of NERICA adoption with positive effects were participation in a training program and living in a village where the SG2000 has had activities. In Benin the main socio-economic determinants with positive effects were land availability and living in a PVS-hosting village. In addition, it was also found in Benin that varietal attributes such as swelling capacity and short growing cycle were important determinants of NERICA adoption.

The ATE adoption model<sup>101</sup> shows the PVS to have played a major role in the adoption of the NERICAs. The finding that the mere conduct of PVS trials in a community promotes the adoption of NERICAs beyond the subpopulation participating in the trials points to a possible strategy for scaling-up PVS: focus on covering more villages with relatively few PVS participants per village (i.e. inter-village scaling-up) and let the naturally occurring phenomenon of "social learning" about the characteristics of a technology do its work within the village community (i.e. the intra-village scaling-up).

### 5.4 Constraints to adoption

One would expect rapid diffusion and adoption of NERICA varieties in SSA. However, the record of spread of NERICAs is rather sobering. Presently, there are an estimated (by WARDA) 150,000 ha of NERICA in SSA, about (50,000 to) 100,000 ha<sup>102</sup> in Guinea (Conakry), about 25,000 – 35,000 ha in Uganda. There is a large uncertainty associated with these area figures. In total, there are 9 million ha of rice in SSA<sup>103</sup>, and about 4.7 million hectare in West Africa, of which 1.8 million upland, or 38.3%. There are about 120,000 ha under NERICA in the uplands in West Africa. Thus, about 6.7 % is under NERICA. This is not surprising after 5 to 10 years of diffusion. Many constraints operate on the diffusion and adoption of NERICAs. Availability of NERICA seed (and complementary technologies) is a big issue as the Nigeria study commissioned by the Rockefeller Foundation/Gatsby Foundation/WARDA (reference below) showed and also the WARDA CCER of NERICA Impact in Guinea by Jacques Brossier (reference below). But also the rice quality issue linked to post-harvest operations is a major constraint resulting in low(er) prices when farmers sell paddy. In addition, many other rice characteristics play a role besides yields per se.

Through all the studies WARDA has conducted over the years on the constraints to adoption (of NERICA), the following has been learned:

- farmers have to be exposed (information) to the merits of NERICAs, otherwise there is no adoption;

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<sup>101</sup> Diagne Aliou, "Taking a New Look at Empirical Models of Adoption: Average Treatment Effect Estimation of Adoption Rates and their Determinants", 26th Conference of the International Association of Agricultural Economists, August 12-18, 2006, Gold Coast, Australia and European Meeting of the Econometric Society, August 24-28, 2006, Vienna.

<sup>102</sup> These are probably the lower and upper limits of NERICA adoption according to the WARDA. See Brossier, Jacques, Evaluation of the impact of NERICA rice varieties in Guinée", CCER WARDA, July 2007.

<sup>103</sup> FAOSTAT

- there is limited farmer-to-farmer adoption, i.e. NERICA's do not spread by themselves from areas or places where adoption has occurred, as is usually the case in Asia;
- availability of (cheap) NERICA seed (requiring government support if the private sector is not performing) is a condition for adoption and growing. Lack of seed often results in disadoption by farmers that have grown NERICAs.<sup>104</sup> Difficulty in obtaining affordable seed is the major reason given for abandoning WARDA varieties. Also, seed shortage is the major reason given for non-adoption of WARDA varieties;
- the main advantages of NERICAs are not high yields per se but rather early maturity, tolerance to water stress, good taste and flavor, short straw. The same attributes in other localities may explain non-adoption. Thus, NERICA adoption effect on farmers' yields is heterogeneous with some farmers not experiencing any yield increase when adopting NERICA. One of the stated advantages of NERICA, strong early vegetative growth and weed suppression, reducing the need for weeding, was not confirmed in the field visits; some of the advantages in some places become distinct disadvantages in other places;
- many farmers grow traditional rice varieties alongside improved varieties.<sup>105</sup> Doumbia found that in the Daloa department of Côte d'Ivoire, 30 rice varieties are known and grown by farmers. In the region of Gagnoa, more than 10 rice varieties are grown in a lowland rice scheme;<sup>106</sup>
- early maturity can lead to massive bird damage if only a few farmers grow NERICA in a locality; bird damage on NERICAs is often given as a major constraint; and
- short straw implies bending over by women harvesting rice by the sickle and is more painful and difficult than for long straw rice. Short straw is a disadvantage if straw is used as animal feed, or if it is used for other purposes, such as roofing.

According to WARDA and the SC, shortage of seed remains a main constraint (SC Q 4). WARDA addresses it as a research component rather than as a simple service element. Other structures such as ARI, PASS (Program on African Seed Systems) or the African Seed Network are also involved. ARI has been created specifically to address the seed issue. Seed issues are discussed in the next section.

The Panel found limited evidence that WARDA really draws the appropriate lessons from these constraints to adoption and adoption studies. WARDA must mainstream social sciences research regarding adoption in the technology generation programs, ensuring better integration and feedback.

Because technology generation must take into account the heterogeneity of the environments and the farming populations, including the different needs of farmers, for better targeting of technologies and better adoption, the Panel recommends that WARDA, in its adoption and impact studies, involve suitable interdisciplinary teams from its research program (breeding, natural resource management, socio-economics).

As we simply do not know, even by a large approximation, the area under NERICA, and since this is important for the overall strategy of WARDA, impact assessment and research guidance, WARDA needs to set up a small, cost-effective project to measure the area under NERICA and

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<sup>104</sup> Spencer Dunstan, Andrew Dorward, George Abalu, Dayo Philip and Diji Ogunbile, "Evaluation of Adoption of NERICA and other Improved Upland Rice Varieties following Varietal Promotion Activities in Nigeria", A study for the Gatsby and Rockefeller Foundations, Final Report, January 2006.

<sup>105</sup> Doumbia, Sekou, Enquête bilan de l'état de l'adoption des variétés améliorées de riz pluvial dans le département de Daloa Zaguiguia 2006, CNRA Abidjan, Novembre 2006.

<sup>106</sup> Doumbia, Sekou, I.J. Keli et M.E. Depieu, "Perception paysanne de l'innovation à travers l'évaluation participative en riziculture: intérêt et limite pour la recherche", *Agronomie Africaine*, No spécial (5), 2004.

other improved rice varieties in the key countries where these are grown and expanding. This needs to be a continuing activity, part of impact assessment. Collaboration with FAO Statistics (FAOStat) and with the national statistical offices is advised. The key countries are presently: Guinea, Uganda, Nigeria, Côte d'Ivoire, Burkina Faso and Benin.

Ideally, the annual agricultural statistics surveys should be complemented with a specific question on the area under NERICA and other improved rice varieties and key agronomic practices in the main rice growing areas. With carefully designed sample surveys, it will be possible to extrapolate to the national level and maintain overall statistical reliability. Enumerators will have to be trained in the identification of improved varieties, as distinct from traditional rice varieties, and in the importance of undertaking this effort. Such a project is best initiated through a workshop organized by WARDA, convening all heads of (agricultural) statistical offices of the countries concerned, with key resource persons from FAO and possibly IFAD and AfDB and regional economic organizations, and participation of ROCARIZ. The workshop proceedings would then form the basis for the project document, to be submitted to donors. As stated, the project should not be a one-off exercise but have a duration of at least five years.

The Panel suggests that WARDA convenes a workshop, with participants from the agricultural statistical offices of the countries with a large area of rice under improved varieties, from ROCARIZ and collaborating international institutions, with a view to designing and implementing a project to measure, in a statistically reliable and cost-effective way, the rice area under improved rice varieties and the prevailing agronomic practices.

## **5.5 Impact culture and measures of impact**

Following the 4<sup>th</sup> EPMR recommendation that WARDA strengthen its capacity to monitor and assess the impact of its activities, WARDA engaged a full-time adoption and impact assessment economist. He works very closely with national partners, supplies software, provides training and backstopping in impact methodologies and in data collection. He has the help of a visiting scientist. In 2006, he spent US\$ 130,000 on adoption and impact assessment studies, most of these funds going to NARI collaborators in the ROCARIZ network. Maybe studies should be done in fewer countries to allow for more in-depth studies.

The impact assessment is conducted under four broad themes:

- Impact of modern varieties on farmer livelihoods and rice bio-diversity;
- impact of improved crop management practices on farmers' livelihoods;
- impact of improved grain quality and post harvest technologies on the rice sector; and
- developing regional capacity in impact assessment through training and joint implementation of collaborative projects.

The main components of the methodology consist of:

- Community and household surveys on knowledge and adoption of varieties and on seed acquisition;
- household and plot levels surveys to collect data on areas and yield by variety, input use, income, food intake, children's schooling, etc.;
- country-wide census or survey data on rice areas and farm populations;
- estimation of dynamic models of adoption based on the ATE methodology;
- estimation of impact on various household-level outcomes based on the ATE methodology; and

- estimation of ex-ante and ex-post impacts on economic and environmental outcomes at the national and continent-wide levels.

Because large datasets are collected, analysis is time consuming. By the end of 2008, the nine ongoing adoption and impact studies will be completed, and it is planned to hold a workshop, resulting in the publishing of a book on adoption and impact. This is to be commended.

The SC Performance Management Results indicators 2006 show for WARDA a very good score (52.6/70) for IA, a very low score for building an IA culture (6.5/20), an excellent score (7.8/8) for communication/dissemination & capacity building and a good total adjusted score of 7.4/10, the third highest in the CGIAR system. One can state that there is an impact culture of social scientists at WARDA with their partner social scientists in the NARS. However, WARDA is the second last in the CGIAR system (just before CIAT) for building an IA culture within the Center. This implies (in the IA performance measurement for building an IA culture) the organization of internal workshops, systematic evaluation of user relevance, use of IA in planning/priority setting and baseline studies. Mainstreaming IA throughout WARDA is thus still a major challenge. *The Panel confirms that building an IA culture at WARDA leaves a lot to be desired and remains a challenge. WARDA should take the necessary action to build an IA culture in the Center.*

Yield impact is still the main indicator, including in uplands. Impact in terms of improved food security, reduced poverty, better schooling of children, longer life expectancy, etc. is much more difficult to assess, needs a longer-term perspective and a much larger adoption of improved varieties. WARDA has started to conduct such studies<sup>107</sup>.

## 5.6 Institutional innovations in seed systems

In 2001, WARDA initiated an innovative participative approach called community-based seed systems (CBSS) to ensure seed access at the grassroots' level. Activities funded by UNDP were coordinated by government extension services – in Côte d'Ivoire by ANADER and in Guinea by SNPRV. The project engaged directly with NGOs and farmer groups. Small quantities of NERICA seed were handed to farmers and accompanied by training in seed production. Farmers thereby became sources of quality seed in their own communities. Seed producers' major constraints were: drying paddy rice during the rainy season; threshing NERICA 4 is very difficult; damage caused by pests (grasscutters, rats, insects and birds); seed conservation; timely availability of fertilizer supply.

Brossier Jacques (2007)<sup>108</sup> in his study on the impact of NERICA in Guinea states the positive impact of CBSS from 2001 to 2004 in the diffusion of NERICAs (with the support of SNPRV, IRAG, SG2000, UNDP and the World Bank and from 2005 on with ARI) but also mentions that private entrepreneurial seed farmers eventually have to take over from CBSS. All important private seed companies in the world (Cargill, Pioneer, Limagrain) started from farmers as seed entrepreneurs<sup>109</sup>. The 2006 Spencer et al.<sup>110</sup> study for Nigeria shows that there are substantial

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<sup>107</sup> Adekambi, Souleimane, Aliou Diagne et Gauthier Biaou, Impact de l'adoption des varietes NERICAs sur la scolarisation des enfants au Benin: cas du Departement des Collines, 2005.

<sup>108</sup> Brossier, Jacques, Evaluation of the impact of NERICA rice varieties in Guinée", CCER WARDA, July 2007.

<sup>109</sup> During the field trips, we encountered some of these emerging seed entrepreneurs/companies: NASECO and FICA in Uganda, FEPRODES in Senegal, Tunde in Bénin.

<sup>110</sup> Spencer Dunstan, Andrew Dorward, George Abalu, Dayo Philip and Diji Ogunbile, "Evaluation of Adoption of NERICA and other Improved Upland Rice Varieties following Varietal Promotion Activities in Nigeria", A study for the Gatsby and Rockefeller Foundations, Final Report, January 2006.

processes of change in seed supply and varietal cultivation ongoing among sampled farmers. It thus has to be an area of constant attention and monitoring by WARDA, also because the international rice market is rapidly changing. In many places, retention of seed of modern varieties from the farmers' own harvest does not seem to be an important seed source and this is puzzling.

WARDA is currently engaged in research on the institutional innovations for the emergence and efficient functioning of local, national and regional seed systems. A major constraint is ensuring farmers' timely access to quality seed by setting up sustainable seed production systems at national and community levels. Another technical constraint more at the system level concerns the timely supply of breeder and foundation seed at the national level in order to ensure regular input in CBSS and other local seed systems. The African Rice Initiative (ARI) is currently strengthening NARES capacity in seed production in seven pilot countries, and is fully engaged in producing breeder and foundation seed as national capacities are developed. This production of foundation seed is considered by WARDA as a temporary but necessary intervention for those countries where capacities are still weak. As the seed systems develop, WARDA's role in producing foundation seed will become limited or non-existent. Then only breeder seed will be produced. The Panel is in favor of such an evolution.

WARDA is currently conducting the following studies on seed systems.

**Innovation system level:** in collaboration with a post-doc from the United Nations University, WARDA is assessing the need for institutional innovations in NERICA seed dissemination at the national and regional levels. The study started in December 2006 and covers Benin, Ghana, Sierra Leone and Guinea; a second multi-country study was started in 2006 by a visiting scientist from Cornell University to assess the formal and informal rice seed system pathways in Ghana and Sierra Leone with a view to identifying bottlenecks and points of intervention for improving farmer access to seeds of acceptable quality; another study aimed at analyzing the structure and function of farmer seed producer groups in ensuring the access of resource-poor farmers to quality rice seed is being started in Guinea and Sierra Leone in May 2007.

## 5.7 Policy dialogue

Creating a conducive and supportive environment for rice development in SSA is of utmost importance for the attainment of the food security and economic development goals set by the countries and the region. WARDA's social science research agenda is very much focused on more effective policy dialogue as a means to setting a conducive policy environment<sup>111</sup>.

The policy domains affecting the rice value chain can be broadly structured into three categories<sup>112</sup>:

- Market, trade and price policies, including regulations and standards;
- environmental and ecosystem policies; and
- research and development policies for innovations.

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<sup>111</sup> We benefited from a monitoring report by Jonathan Coulter and Bohumil Havrand on "Policy Environment and Rice Market Development", project 3.2. (Project 5) for the European Commission, dated November, 2005. The European Commission partly finances policy research at WARDA.

<sup>112</sup> Von Braun, Joachim, Public policy and international collaboration for sustaining and expanding the rice revolution, Keynote at the 2nd International Rice Congress on "Science, technology and trade for peace and security", New Delhi, October 9-13, 2006.



WARDA, more than any other CGIAR Center, is well placed to engage in policy dialogue in SSA, through its Council of Ministers (COM), which meets every two years, and its associated National Experts Committee (NEC) (the heads of the NARS of the member countries) which prepares the meetings of the COM. The COM and NEC have made statements giving resounding support to WARDA's policy work. WARDA has made frequent assertions in presentations and publications that the policy environment for rice development in SSA is negative or unfavorable. This by itself can be questioned as most countries practice some form of import protection. However, at the same time, they could do much more for national rice research and development.

It is in the COM in particular that the seed issue has been discussed and that it was decided to create ARI. WARDA's publication on "Rice Trends in Sub-Saharan Africa" is a crucial background statistical document on policy dialogue but it is updated infrequently and contains no analysis. To be effective, it needs to be updated once a year and commented.

Regarding rice development policies, what is also lacking is a continuously updated document on the rice policies in place in each of the Member Countries, as detailed as possible (in a comparative table or overview document). This document should include the rice import policies, policies regarding rice production inputs (seeds, fertilizers, water pricing in irrigated schemes), rice prices to producers and in the market, taxation of rice consumption, the main rice research and development projects, with their budget, regulations and standards affecting the rice sector. *The Panel suggests that WARDA updates its "Rice Trend in Sub-Saharan Africa" annually and prepares and continuously updates a "Rice Policies in the Member Countries" overview document.* Undoubtedly, WARDA could be more effective in policy dialogue, but this is only possible if more and better policy analysis research is conducted (see 2.4. on social sciences in WARDA). WARDA supports the Agricultural Policy Research and Advocacy Group (APRAG), which allows transmittal of research findings to national and regional policy makers.

Attempts to establish a joint appointment on policy research with IFPRI never succeeded. No concrete collaboration has been achieved, although every review of social sciences at WARDA mentions it as desirable. Even in the SWIHA program, collaboration with IFPRI is minimal. It is not clear why such collaboration cannot materialize, but WARDA attributes it to IFPRI's desire to always take leadership and initiative. The WARDA-IRRI recent workshop listed policies as an area of collaboration. Thus, joint efforts should be made to collaborate effectively with IFPRI on rice development policies in SSA.

## 5.8 Conclusions

The Panel had difficulties understanding WARDA's adoption and impact studies. Unless the agro-ecological and socio-economic context is made clear and explicit, the results obtained are difficult to gauge. There is a danger in adoption and impact studies that are too generic --.country wide, across all environments. WARDA's approach to adoption and impact studies should not be limited to a snapshot approach of adoption and yield impact. Yield stability over time, adoption of improved agronomic practices and the effect of (rising) paddy prices paid to farmers should also be considered in adoption. WARDA developed a new methodology for adoption studies; the PLAR method for technology transfer; and mainstreamed PVS and CBSS in its partner countries. So many constraints operate on adoption that more interdisciplinary teams from the research program need to be involved in the adoption studies.

Regarding NERICA's, some advantages in one place may be distinct disadvantages in another. The seed issue remains a critical constraint, and WARDA needs to be careful in its judgment how

far it can go to meet needs, in line with its comparative advantage as a rice research Center. There is a great need for better data on areas under modern rice varieties and improved agronomic practices. We suggest a workshop on the issue with all concerned partners as a starting point. Regarding an impact culture and measures of impact, the Science Council indicators show a very good score for WARDA, but also a very low score for building an IA culture at WARDA. To improve on this, impact assessment in WARDA's research program needs to be mainstreamed. Finally, regarding policy dialogue, APRAG is an excellent mechanism but it can only be successful if more and well focused policy research is conducted and if full advantage is taken of the NEC and COM structures at WARDA.