# Assessing the Impact of NERICA Rice Varieties: Not Just Surveys and Simple Mathematics

'IMPACT ASSESSMENT' has been a 'buzz-word' among donors for some years now. It has become so important that WARDA hired its own Impact Assessment Economist in 2000. Does that seem like a lot of money to spend on simply measuring how well we're doing our job? After all, it's only a matter of a little survey work and some simple calculations, isn't it?

Why does WARDA carry out rice research and development? Surely one answer might be: To improve rice production and rice productivity in its member states. Perhaps a more general answer might be: To improve 'something.'

Much of WARDA's funding comes from 'public funds,' either from donor countries or from the member states themselves. For some years now, there has been an onus on governments to show their citizens what they do with their taxes. Consequently, there has been the knock-on effect that donor agencies ask organizations like WARDA to show what they have achieved with the money that they have been given. Thus, WARDA (and many other organizations worldwide) has to assess its impact or, put another way, conduct impact assessment.

After a strong recommendation from WARDA's External Program and Management Review in early 2000, Aliou Diagne was recruited as Impact Assessment Economist in mid-2000. In particular, WARDA wanted to know the real impact of its technologies rather than relying on anecdotal data. This was especially so in relation to the NERICA rice varieties that 'took the world by storm' as their fame spread after the Millennium CGIAR King Baudouin Award was presented to WARDA for the NERICA work.

## What do we improve, what do we measure?

"One of the crucial aspects," explains Diagne, "is adapting impact-assessment techniques to modern demands." In the past, researchers had been satisfied with a simplistic approach to impact, they wanted answers to questions like: "How many farmers have adopted the technology?" and "How much of the rice area is under the influence of my technology?"

"Like other CG Centers, WARDA now has a mission to reduce poverty, so our stakeholders rightly want to know how well we are doing," explains Diagne. "Now, we have to ask questions related to social welfare—for example, do the farmers have an 'easier' life as a result of adopting our technology? Do consumers have cheaper rice on the market? Do farming families have cash to spend on improving their lives in general, like investing in health-care? And then there are broader issues of the overall benefit to communities, questions of equity, gender and environmental impact." WARDA Management also needs such information to improve the relevance, effectiveness and efficiency of the Center's research.

Given these complexities, Diagne has invested some time working on methodology—in other words, what is the best way of making such impact assessments. "What one has to bear in mind," explains Diagne, "is that there is a fundamental problem to all evaluation work, namely that it is impossible to observe the counter-factual outcome corresponding to any technological, institutional or policy change being considered. In other words, if the change does occur, one cannot observe what would have happened to the outcomes in the absence of the change, and vice versa." In addition to developing methodology, Diagne and his team also spent a lot of time collecting plot and household data (such as income and consumption) to provide a baseline from which to assess impact on poverty and livelihoods.

So, what about those varieties?

"We have made strong claims about our NERICA varieties," says Director General Kanayo F. Nwanze. "Now we need some hard evidence on how well they are doing in the farmers' fields."

## Varieties in Côte d'Ivoire

"Before we look at the NERICAs in particular, it is necessary to have a broader look at variety use on farm in general," says Diagne. "What is more, we still have to start with adoption studies—after all, how can we determine the effects of, say, new varieties on poverty if we don't know how widespread those varieties are within farming communities?" To this end, surveys were conducted in 2000, within the framework of a project, funded by the UK Department for International Development (DFID), on rice biodiversity and the history of variety use and diffusion, in and around four sites that had been exposed to new varieties. Some 1500 farmers in 50 villages were sampled covering both those where WARDA had been active and neighboring villages that had not previously been visited by WARDA staff.

"The results are shocking!" exclaims Head of WARDA's Genetic Resources Unit Gouantoueu Guei, "especially for those who expect instant adoption and impact."

The average village community knows about 25 varieties, of which 21 are traditional varieties and four modern. The four modern varieties comprise three extended by the national program and one from WARDA.

Meanwhile, the average individual farmer knows 14 varieties—typically 12 traditional and two modern. However, from those that he knows, he only grows four in any one season—three traditional and one modern. Overall, 75% of farmers surveyed knew at least one modern variety, while 28% knew at least one WARDA variety.

Over the five years 1996 to 2000, average farmer portfolio (of cultivated varieties) increased from 3.4 to 4, with increases in all classes (i.e. traditional, NARS and WARDA)—*see* Figure 4. Over the same period, the proportion of farmers growing each type of variety also increased (Fig. 5).

What does this low level of adoption of WARDA varieties mean for WARDA? Has it failed in its mission? "By no means!" says Diagne. "What we are seeing here is typical of variety adoption patterns—there is a long time-lag between development of a variety, its release and subsequent wide-scale adoption."

Ivorian student Yao Djea was brought in to study this very issue as part of his DEA [like Master's] degree.

**Figure 4.** Type and average number of rice varieties cultivated by a farmer

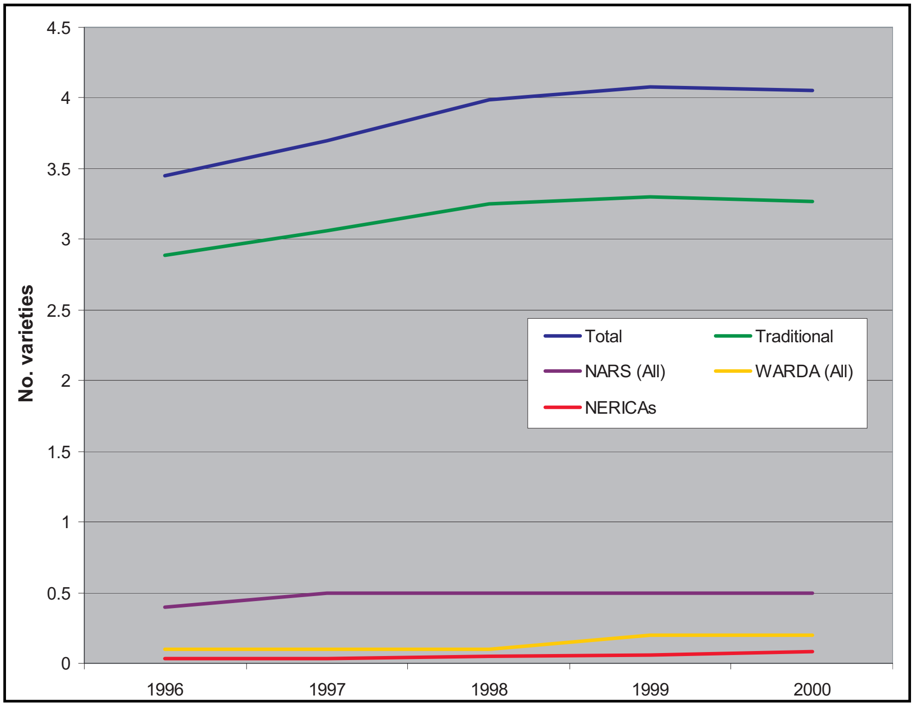
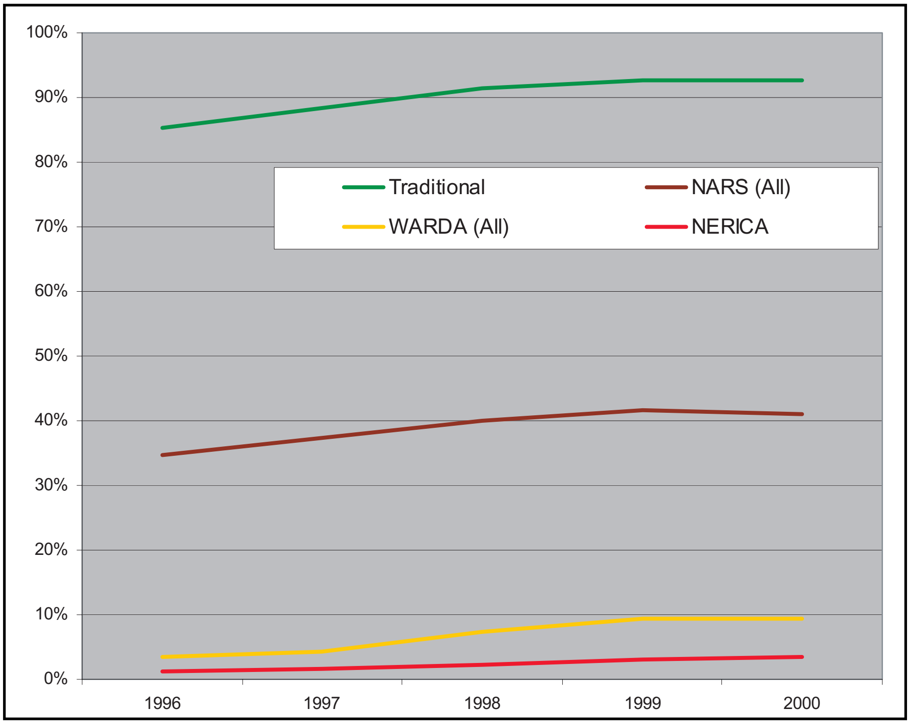



**Figure 5.** Proportion of farmers cultivating each type of variety



"The dates and figures really speak for themselves," he explains. "The national program started introducing modern varieties in 1973—though some of them had been introduced by the French and Chinese in the early 1960s. After 27 years, they can claim up to a 14% stake in the average farmer's variety knowledge and up to a 25% stake in his portfolio per year. WARDA varieties were not available in Côte d'Ivoire until 1989, and none was actually officially released until 1998, so we should not expect them to have had much impact by 2000."

So, what we are saying is that it is perhaps too early to measure the impact of WARDA varieties in Côte d'Ivoire.

Similar studies are being conducted in Guinea. "The results are not yet available from Guinea," explains Diagne, "but I would expect some differences in adoption rates of, especially, WARDA varieties, because of the Government program to revitalize the upland-rice sector with support from Sasakawa Global 2000, and using WARDA varieties. The main constraint to the adoption of modern varieties of all types is the diffusion rate and its consequent effect on farmer knowledge about such varieties."

## A closer look at the NERICAs and their adoption

Having said that it is too early to assess the overall impact of NERICAs to date, it is perhaps only fair to look at their impact on those communities that have been exposed to them, and thence estimate their potential impact if they were widely disseminated (as proposed by the African Rice Initiative, ARI).

Let us first take a closer look at the NERICAs themselves. Anyone familiar with WARDA's work over the last decade is sure to know about NERICA, but let us recap for the newcomers.

NERICA—New Rice for Africa—was developed at WARDA by the crossing of 'Asian' rice *Oryza sativa* with indigenous African rice *O. glaberrima*. The goal of the breeding program was to combine the yield-related attributes of the Asian (e.g. non-shattering heads,

### The problem of identification

"One of the principal problems to variety impact work is collecting quality data," says Impact Assessment Economist Aliou Diagne. "This is especially a problem when we want data separated out for something special, such as the NERICA varieties."

Key to collecting data specifically on NERICAs, is the ability of everyone involved to be able to identify the varieties concerned. One issue here is naming: "WARDA did not help itself in the early days," says Diagne, "because it distributed large numbers of varieties for participatory varietal selection (PVS) trials under complex code-names developed by breeders. Names like WAB450-11-1-P31-1-HB and WAB450-11-1-1-P31-HB were simply asking for clerical errors to creep in!" The names also caused problems for the farmers, who tend not to relate well to the abstract ideas of letters and numbers for their varieties.

"Farmers tend to give varieties that they adopt their own names," explains Head of Genetic Resources Unit Gouantoueu Guei. WARDA has reported before that varieties adopted from PVS trials have been dubbed 'ADRAO rice,' with no further distinction.

Once we start looking at farmers who have not participated in WARDA-led trials, naming gets even more complicated. Farmers may name a variety after the neighbor or village they obtained the seed from, and may have no idea what a NERICA is compared to any other modern variety.

"If the naming issue is not bad enough, even participating farmers have difficulty in distinguishing some varieties from each other," explains Diagne. "To help overcome this problem, later survey teams took seed samples of the varieties known to be in each community for direct comparison with the farmers' grain and consequent identification of varieties."

"Astonishing as it may seem given the level of exposure to WARDA varieties there, farmers and researchers in Guinea experience exactly the same problems with names and variety identification!" exclaims Director General Kanayo F. Nwanze.

A related issue was raised when surveyors tried to determine the area planted to each variety. "Given the complication of naming and identification, and the irregular shape of upland rice fields, it is not surprising that farmers cannot provide area data by variety," explains Diagne. "To overcome this, we are combining in-the-field identification with field measurement and global position satellite (GPS) technology."

resistance to lodging, yield potential) with the local adaptation of the African (e.g. pest resistance, drought tolerance, weed-suppression). "As with any hybridization, what we should expect from the offspring is some sort of middle ground between the parents," says Diagne, "and if we achieve that, we should say that we have succeeded."

Regular readers of these Reports will be aware that some NERICA lines in fact out-perform their parents. For example, some lines have significantly more protein than the parent with the highest protein content, and some lines have considerably more grains in their panicles than either parent.

"The main drawbacks to NERICA adoption to date," explains Diagne, "are the relatively few farmers who have been exposed to them and seed supply. Côte d'Ivoire released the first two NERICAs late in 2000, but still could not meet demand for seed for the 2002 [pre-war] planting season." Prior to 2000, and starting as recently as 1996, NERICA diffusion was entirely through research activities, such as participatory varietal selection (PVS) and on-farm trials. "In our survey, only 139 of the 1500 farmers questioned had even *heard* about NERICAs—that is only 9% of the sample population!"

With only 9% of the sample having been exposed to NERICAs, it is no surprise that we find that the proportion of sample farmers who have adopted them is a mere 4%. But, according to Diagne, this commonly calculated 'sample adoption rate' (i.e. the proportion of the sample that has adopted) is a very biased estimate of the true *population* adoption rate, because it suffers from what he calls 'non-exposure' bias.

The 'non-exposure' bias results from the fact that farmers who have not been exposed to a variety cannot adopt it *even if they might have done so had they known about it*. This results in the *population* adoption rate being underestimated; however, this underestimation decreases and eventually disappears as the exposure of the population to the new variety increases (*see* Fig. 8, page 40).

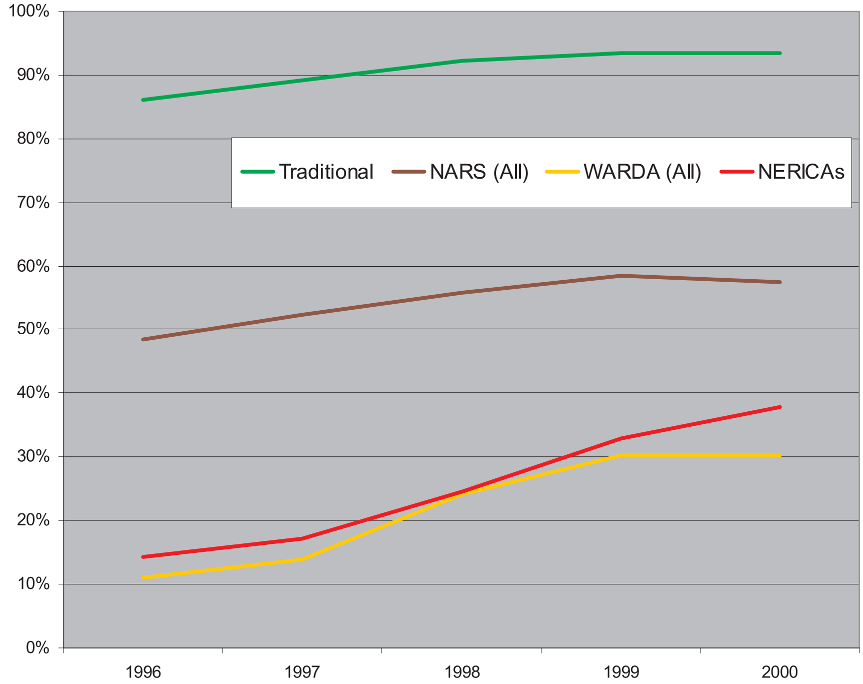
In fact, the sample adoption rate is an estimate of population exposure *and* adoption rate, namely, the proportion of farmers in the total population who have been exposed to the variety *and* who have adopted it. However, the question we are interested in (in an adoption study) is the extent to which farmers *like* a given variety and not the extent to which they *know* about it. Indeed, it is the answer to the question "how much is a variety liked?" that provides feedback to researchers about the suitability of their research in meeting the needs of the target population—in our context, it also provides the feedback to donors and research managers on whether the NERICAs are living up to their reputation as being well liked by farmers. The answer to the question "how well-known is the variety?" is most useful for extension purposes.

Thus, our 4% adoption rate of NERICAs provides little information on the population adoption rate because exposure is so low.

"If we look only at those farmers who have been exposed to NERICAs, however, and given the short time since their initial exposure to them, the adoption rates are impressive," says Diagne (*see* Fig. 6). Some 38% of farmers in the study area who had been exposed to NERICAs had adopted them by 2000. So, potential impact is merely a matter of extrapolating from that figure? "Not exactly," says Diagne. "We have to bear in mind that there is a certain selection bias of those exposed that is reflected in the sample, even if the sample is randomly selected from the population."

Those who adopt NERICA have first to have heard about NERICA. The first group of those who know about NERICA is those who have been involved in some sort of trials—on-farm, PVS or community-based seed production. "Here we see a bias in targeting by the research and extension agencies," explains Diagne, "toward progressive farmers, who are more likely to adopt new technologies than the 'average' farmer."

**Figure 6.** Proportion of farmers cultivating each type of variety among those exposed to those variety types




Then there is the self-selection process of non-participant farmers who learn about and subsequently adopt NERICAs. "Those farmers that actively seek out improved technologies are more likely to find out about the NERICAs first *and* are more likely to adopt them," explains Diagne.

These biases affecting the exposure of farmers lead to an overestimation of impact, as adoption rate among those exposed to date is greater than what is expected once the whole population is exposed (*see* Box 'The problem of selection bias').

How then, under partial exposure, can one obtain a good estimate of the true population adoption rate if the only two adoption rates that can be calculated are excluded on the basis of their inherent biases? "This is where modern impact-assessment methodology based on what we call 'the counterfactual setting framework,' comes to the rescue," explains Diagne.

The true population adoption rate corresponds to what is defined as the 'average treatment effect' (or ATE), which is the effect of 'treatment' (in our case, exposure) on an outcome (in our case, adoption) of a person randomly selected from the population. In addition, impact-assessment researchers define 'average treatment effect on the treated' (ATE1)—the effect of treatment on the sub-population of those actually treated. In the NERICA studies, this amounts to the adoption rate among those exposed.

Consistent estimation of ATE requires appropriate control for exposure status and for the demographic, institutional and socio-economic factors that influence both exposure and adoption. The exception to this is when treatment is randomly applied across the population, in which case ATE equals ATE1 and equates to true population adoption rate.

## The problem of selection bias

The overall farmer population can be divided into two groups: the 'adopter types,' who will adopt the particular variety once they have been exposed to it, and the 'non-adopter types,' who will not adopt the variety even after they have been exposed to it. In our analyses, it is assumed that any particular farmer's type is not evident until such time as he or she is exposed to the variety in question. Thus, until the whole population has been exposed to the variety, the overall ratio of 'adopter types' to 'non-adopter types'—which would give us the population adoption rate—is unknown.

We illustrate this in Figure 7. 'Adopter types' are indicated by ⊕, and 'non-adopter types' by ⊗. The general situation is illustrated in A, where 'adopter types' and 'non-adopter' types are randomly distributed through the population. At the time of the impact-assessment survey, some farmers have been exposed to the variety; their type is now known and they are shown by color-reversed symbols (B). The survey sample itself is made up of a random sample from the whole population, comprising a mixture of adopters (exposed), exposed non-adopters, unexposed non-adopters and unexposed 'adopter types.' It is only when the ratio of adopter types to non-adopter types is the same among exposed farmers as it is in the whole population that the sample adoption rate among exposed farmers represents the population adoption rate (scenario C in Fig. 8). However, when the proportion of adopter types is higher among the exposed group (as is expected to be the case for the NERICAs), the sample (Fig. 7C) adoption rate among the exposed will exceed that of the population (*see* Box 'The effects of non-exposure and selection biases on estimations of population adoption level,' page 40).

The sample adoption rate itself is always lower than the true population rate when exposure of the population is not complete (scenarios A, B and C in Fig. 8).

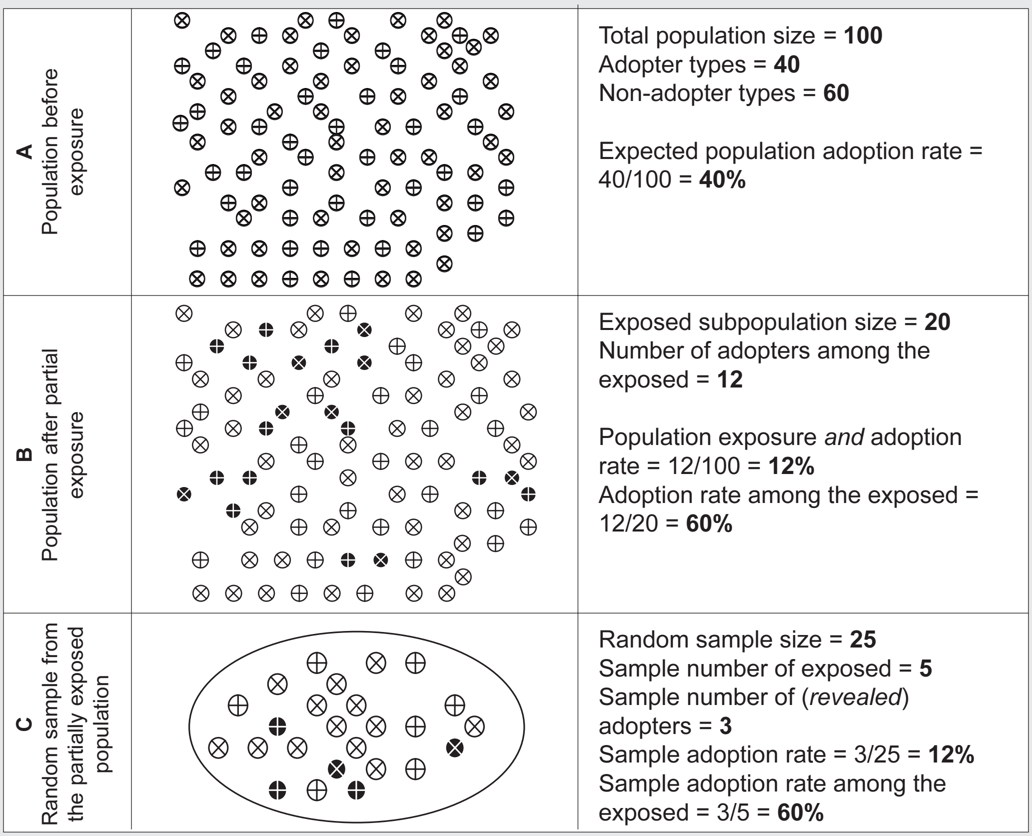



**Figure 7.** Population non-exposure and selection biases—the effect of partial non-random exposure among 'adopter type' (⊕) and 'non-adopter type' (⊗) farmers (see text above)

## The effects of non-exposure and selection biases on estimations of population adoption level

The targeting of dissemination activities for new varieties (and other technologies) has a direct impact on the applicability of sample adoption rate to population adoption rate. As discussed in the main text, the NERICA program is still in its early days, and exposure is strongly influenced by selection biases favoring the exposure of 'adopter type' farmers in the early years. Figure 8 illustrates the effects of non-exposure and selection biases on estimates of population adoption; scenario A best represents the current situation in assessing the adoption impact of NERICAs.

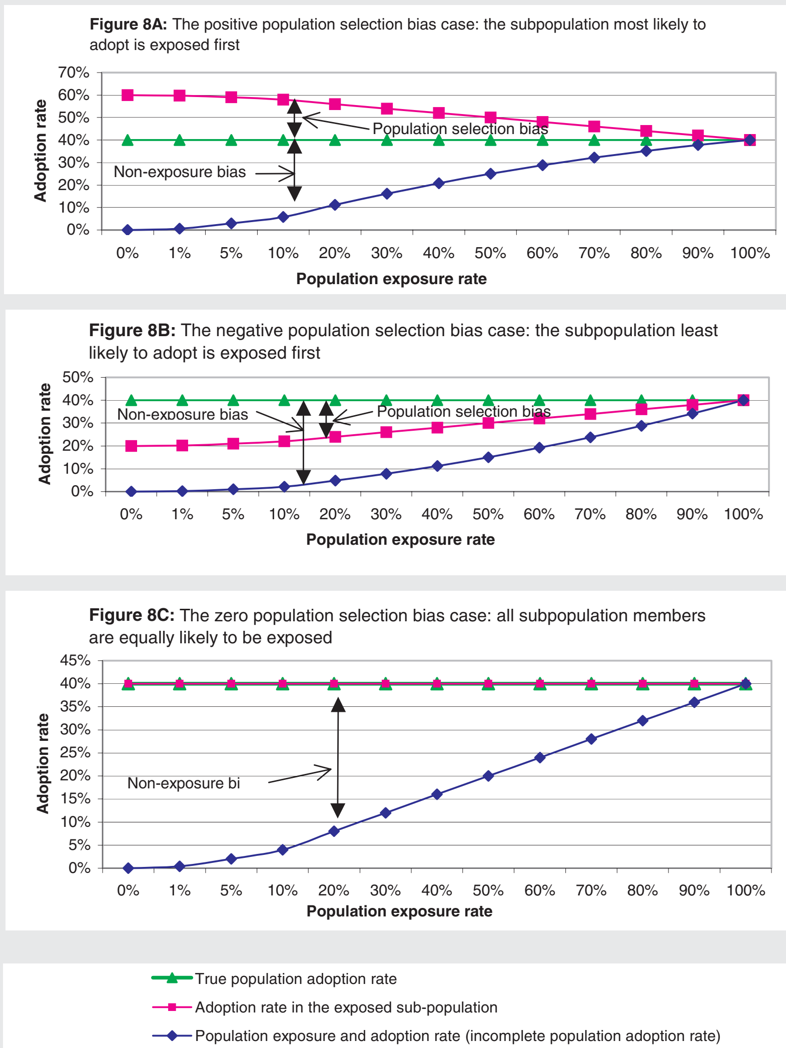



**Figure 8.** Population adoption rates and non-exposure and selection biases as function of exposure rate

## The potential of the NERICAs

At the end of the day, Diagne determined that *if* the whole rice-farming population had been exposed to NERICAs in or before 2000, then the adoption rate in 2000 would have been 27%. Thus, we can see a significant and large effect of 'non-exposure bias' in the 'sample adoption rate' of 4%. In other words, 23% (= 27 – 4) of the total farmer population is determined as being 'adopter types' who had not been exposed to NERICAs at the time of the survey.

There is also a positive effect of past adoption. For example, the effect of adoption in 1999 on adoption in 2000. This can be compounded and projected as in Fig. 9 (page 41). The projection shows a long-term adoption rate of 76%; however, there is a long time-lag of about 25 years to this point of 'maximum' adoption. Nevertheless, NERICA adoption is projected to rise rapidly from the 2000 level, reaching 68% as early as 2006. So, we can say that about two-thirds of the population would have adopted NERICAs by 2006, if the whole population had been exposed in or by 2000. This indicates a large potential impact for any large-scale NERICA dissemination project.

"This does not mean that we expect two-thirds of the farming population to have adopted NERICAs by 2006," Diagne says, "but it is the nearest estimate that we can generate at this time, in terms of the extent to which NERICAs will be liked (or demanded) by the rice-farming population at that time.

"Ultimately, actual adoption will be influenced by new and external factors and may be either greater than or less than the estimate we have today." One such new factor is the drive to promote NERICAs through the African Rice Initiative throughout Sub-Saharan Africa, the aim of which is to encourage even greater diffusion and adoption of NERICAs. Another factor is the on-going generation of NERICAs, which may play a significant role in the future adoption figures.

"NERICA is a technology, not simply a product," explains Rice Breeder Howard Gridley. "The technology is in place to generate new NERICA lines and these should be fitted to farmers' needs and introduced into the variety portfolios as needed."

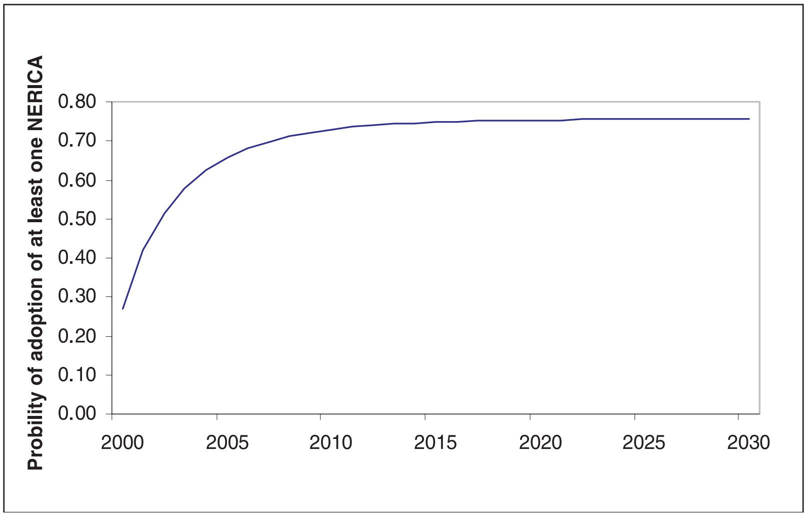



**Figure 9.** Projected NERICA adoption over time