Seedling

Biodiversity, Rights and Livelihood

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Genetic Resources Action International (GRAIN) is an international non-profit organisation which promotes the sustainable management and use of agricultural biodiversity based on people's control over genetic resources and local knowledge. To find out more about GRAIN, visit our website at www.grain.org

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Front cover pictures: © Jan Banning / Panos Pictures, Cambodia: Students at the Laboratory School in Phnom Penh; Masangari Yesu, Pastapur, India: Women farmers performing a paricipatory crop mapping exercise.

Back cover picture: © Crispin Hughes / Panos Pictures. Near Ntcheu, Malawi. Farmer waiting for the rains in order to sow her seeds.

Public research theoretically offers considerably more potential than the corporate, gene-focused approach to generate crops that meet the needs of farmers. But in practice, much public research, especially that undertaken by the world's international research centres, has also been blinded by the gene. *Aaron deGrassi* and *Peter Rosset* assert that farmers need to be returned to centre-stage to re-assume their central role as custodians of the world's agricultural resources and the directors of research and innovation.

Public Research: which public is that?

AARON DEGRASSI AND PETER ROSSET

For many years, the International Agricultural Research Centres (IARCs)[1] focused their research efforts almost exclusively on three crops: maize, wheat and rice. The many varieties they developed were grown under controlled environments with regular inputs of water, fertiliser, pesticides and labour. This strategy was heavily criticised in the 1970s and 1980s for ignoring the many so-called *"minor crops"* that poor farmers depend on in the uncertain, resource-poor environments where they often live. This led the IARCs to expand their menu to include new criteria and new crops, such as roots and tuber, legumes, and other critical sources of calories and protein. But this list still falls short of the real crop diversity farmers use, and the emphasis in breeding continues to be on improving one or a small number of traits applicable to broad ranges of farmers, whilst farmers have multiple, location-specific criteria.

[1] The IARCs are a group of 16 publicly funded research institutes that claim to *"work in more than 100 countries to mobilise cutting-edge science to reduce hunger and poverty, improve human nutrition and health, and protect the environment".* The IARCs are the biggest institutional force guiding research and development for the crops that feed people in the South.

Mainstream research and development, as practised by the IARCs, depends on natural scientists (and occasionally social scientists) evaluating new technologies, sometimes with the use of farmer surveys. However, scientists' evaluations become rather complex and difficult when there are numerous characteristics to compare and correlate. In the midst of such complexity, many researchers attempt to evaluate the performance of new technologies and traits by using a relatively restricted criterion: yield. *"Yield"* refers to the output of a single crop measured in weight per hectare, for a single season, without regard to the cost of the inputs required to obtain it or the market price the crop fetches. Because the notion of yield reduces the evaluation of the value of a variety to a single variable, it can be termed a *reductionist* measure.

Reductionist measurements are severely inadequate as a basis upon which to judge whether one variety is superior to another, precisely because such measures fail to incorporate other variables crucial to farmers' production. The unstated assumption of conventional breeding is that *"local"* and *"improved"* varieties perform exactly the same in all respects but the one variable in question. A typical study claims that *"by simply switching to the new variety – with no change in crop management – small-scale farmers can increase yields by 10-30%."*[2] Researchers assume that characteristics can be treated in isolation, and breeders can 'turn the knob up' on, say, disease resistance, without affecting other characteristics, like taste. Yet varieties often contain multiple, linked characteristics that change during breeding, and do not remain constant.

For starters, reductionist yield measures all too often do not take into account the costs of labour or capital inputs required by a variety: a high maize yield per hectare means little if it entails proportionately higher costs to farmers (in fertiliser, hybrid seed, extra labour for row planting, for example).[3] Norman Borlaug's Sasakawa 2000 (SG 2000) programme to promote Green Revolution technology failed to adjust the amount of fertiliser it was recommending in Ghana, despite an increase of the price of fertiliser by several hundred percent.[4]

Simplistic conventional analysis frequently also fails to seriously address how marketing opportunities affect the profitability of new technology packages. In Mozambique an SG 2000 project advocating a package of improved varieties and purchased inputs characteristically stated: *"The large **yield** differences between the traditional plots and those cultivated with the improved technologies … clearly demonstrates the role improved inputs lay in augmenting maize yields"*[5] (emphasis added). However, the *"yield advan-tage"* looks very different if we take into account economic factors such as how crop prices vary at different times of the year, and in particular how prices drop during the harvest season. In the SG 2000 example, farmers adopting the package of technology may have had higher yields, but adopter-farmers who sold their harvest during the market glut did not have a substantially higher net return on their investment than non-adopters, and, moreover, risked having substantially lower net returns than non-adopters.[6] In other words, a new set of technology may raise physical yields of food per hectare for a single season (the concern of reductionist research), but that does not necessarily make it more profitable for farmers.[7]

Mainstream researchers are unable to see how the circumstances at research stations where crops are tested differ greatly from the (varying) conditions poor farmers face. Such incongruity between station and fields encompasses *biophysical* settings (topography, soil type and condition, macro/micronutrient deficiencies, plot size and shape, hazards, pests and diseases, water supply, natural vegetation, crop mixtures) as well as *socio-economic* constraints (timely and affordable access to purchased inputs, seeds, credit, labour, extension consultation).[8] Not only do typical reductionist analyses obfuscate yield and farmers' profitability, but gene-environment interactions make yields attained on-station hard to reproduce in the face of real-world variation.[9] What seem like good seeds at the station often turn out to be inadequate in many farmer's fields. At a research station at Cinzana, Mali, soil fertility discrepancies caused intercropping techniques to yield two to three tons on station, but only one ton off station, and *"many millet and sorghum varieties developed on station gave significantly lower yields than local varieties."*[10]

The SG 2000's own data show *"larger variations, for both 'traditional' and 'improved,' among farmers and between years, than the mean differences between 'traditional' and 'improved' yields in a single year"* – that is, there is often a bigger difference between farmers using the same technology package than between the packages themselves. Even on-farm trials, when conducted under the purview of reductionist science, can mislead if the uniqueness of the (usually wealthier, male) farmers involved goes unnoticed. For example, the farmers participating in an on-farm SG 2000 trial in Ethiopia were said to *"cultivate more land (both absolutely and per capita), have larger household sizes (ie more available labor), appear to be wealthier (more livestock and traction animals), and have better educated household heads than they typical households."*[11] Such specificity renders obsolete the relatively broad, uniform recommendations developed by research stations operating under privileged conditions.

In summary, most conventional research and evaluation structures are premised upon three underlying assumptions:

(1) Crop varieties are best evaluated on the basis of one variable – absolute, short-term output per hectare – or, occasionally, several variables;

(2) The new varieties developed by centralised rese-archers perform better in this respect;

(3) Such varieties will thus be readily adopted by farmers if only they are made *"aware"* of them.

This reductionist approach is ill-equipped indeed to cope with the complex, diverse and risk-prone nature of smallholder production in Africa. Many

[2] SMIP, *New Horizons for Research Partnership: the SADC/ICRISAT Sorghum and Millet Improvement Program,* 1999, www.cgiar.org/icrisat/text/research/networks/gnet5

[3] HCC Meertens *et al, Dynamics in Farming Systems: Changes in Time and Space in Sukumaland, Tanzania,* Netherlands: Kit Press, 1995.

[4] MJ Yudelman *et al, An Evaluation of the Sasakawa-Global 2000 Project in Ghana.* In, NC Russell and CR Dowswell (eds.), Africa's agricultural development in the 1990s: Can it be sustained? : Proceedings of a Workshop, Arusha, Tanzania, Mexico, D.F: CASIN/SAA/Global 2000, 45-56, 1992

[5] JA Howard *et al,* "An Appraisal of the Inputs Subsector and the 1996/97 DNER/SG2000 Program". *USAID-MSU Food Security II Cooper-ative Agreement Policy Synthesis No. 38,* Michigan State University, 1998.

[6] The yield difference was 4.1 tons/ha vs 2.5. Of those who sold late, farmers who adopted the package received a net benefit of $58-$197 per hour while non-adopting farmers received $142-$185 per hour.

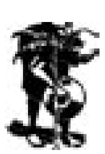
[7] This might be obvious to economists, but they are frequently sidelined in agricultural research, or releg-ated to after-the-fact impact evaluations.

[8] R Chambers, "Farmer-First: A Practical Paradigm for the Third Agriculture", In: M Altieri and SB Hecht (eds.), *Agroecology and Small Farm Development,* p 239, Ann Arbor: Uni. of Michigan Press, 1990.

[9] IITA, *Sustainable Food Production in Sub-Saharan Africa: IITA's Contribution,* Ibadan, Nigeria: IITA, pp 91-104, 1992.

[10] See ISNAR *et al, Lessons Learned: A private-sector foundation's support to devel-oping country agricultural research,* ISNAR, 1995.

[11] JA Howard *et al*, 1998, see above.



experiments and projects have been repeatedly confounded by the diversity of environments, farmers and criteria.[12] Yet, after research and evaluation structures have failed to transplant standardised seeds into the cropping systems of farmers, sometimes these seeds are subsequently crossed by the farmers themselves with indigenous varieties with hardy traits, producing new varieties of interest to them.[13] This strongly suggests that participatory testing and breeding can better take into account multiple characteristics of varieties and farmers priorities farmers.

Limiting access and undercutting farmers

In addition to its incapacity to devise appropriate varieties, conventional research and extension will not meet new pro-poor and environmental objectives because it also works to substitute – rather than facilitate – vitally important farmer-to-farmer networks of innovation and exchange. Farmers often possess dynamic seed saving and exchange systems that extend out in nested or concentric arenas, from households, villages, districts, countries and even regions, providing access to seeds and producing innovations. When cassava was introduced in the 1500s by the Portuguese, it spread across the African continent and was adapted in numerous different ways. Likewise, farmers have shared and adapted maize varieties with extraordinary skill. Farmers networks intersect to provide key points of innovation, diffusion, and adaptation.[14]

Loans, exchanges, gifts, and purchases are all key ways farm families exchange seeds. At the same time, there is abundant evidence that smaller or poorer farmers rarely get formally developed seeds at all, even less so through formal institutions of seed distribution. For example, in two districts in Kenya the use of 'improved' varieties was significantly associated with having attained secondary education, ownership of cattle, use of hired labour, location, and access to extension – all class-based variables. In the central highlands of Ethiopia, both the private sector and state extension systems are relatively ineffective for wheat: *"the formal sector produces and distributes only 15% of the improved seed requirement of the country. Most farmers rely on other farmers and local markets to replace seed, obtain new seed, and obtain information on wheat varieties."* [15]

Centralised research works to subvert farmer-based networks, in part because seeds are collected to deposit in gene banks – based at the IARCS and National Agricultural Research Systems – where only researchers and companies with financial means have access to them.[16] The top-down nature and limited value of genebanks is exemplified by the fact that researchers collect seeds without collecting commensurate information on how such seeds are used, by whom, under what conditions. Rather, seeds are collected and valued only for use by researchers to conduct standardised mass trials or virtually random crosses.[17] Sometimes gene banks are seen almost as making it unnecessary to preserve 'living varieties' in the field. For example, a recent evaluation panel recommended that *"due to the extension of new 'NERICA' upland rice varieties which will lead to loss of indigenous genetic resources, the research institute that developed the new varieties, WARDA, should intensify the collection and conservation of indigenous upland rice varieties."* [18] But such efforts to ensure genetic diversity would be misplaced to focus only on salvaging seeds that are soon to be lost from farmers' fields, because it is the living seed systems that characterise active communities and farmer networks where varieties are continually adapted to changing conditions.

Proponents of the 'Green' and impending 'Double Green' revolutions claim that new varieties actually add genetic diversity, by bringing new genetic material to farmers' fields.[19] However, the genetic depth of new varieties is vastly overstated, and, more importantly, these assertions emphasise the additive nature of new seeds that, in practice, are a promoted as *replacements* – farmers are effectively urged to ditch old seeds and praised for devoting all of their fields to one variety from a research station. This process of genetic erosion inevitably leads to the loss of vital genetic resources – and the IARCs are contributing to it in a big way.

ICRISAT/SADC proudly states that, *"In Zimbabwe, SV 2, released in 1987, is now grown on 30% of the country's sorghum area; PMV 2, released in 1992, occupies 25% of the pearl millet area. In Namibia, Okashana 1 covers an estimated 45-49% of the pearl millet area. In Zambia, four recently released varieties cover 35% of the sorghum area."* [20] Much of the improved maize in West Africa derives from only two initial populations from Nigeria and Mexico (TZB and Tuxpeño, respectively).[21] WARDA advocates that all farmers grow the same kind of rice on all their fields continuously, rather than the diverse mosaic farmers currently have, with different kinds of rice and diverse non-rice crops (such as sorghum, peral millet, groundnuts, chillies, etc). Already, one WARDA variety (Sahel 108) makes up 75% of the irrigated rice grown dry season in the Senegal River Valley.[22] Between replacement and gene flow – pollen from widespread new varieties can inundate the flowers of traditional varieties, diluting their genes – the Green Revolution extinguishes the base from which it was built.

[12] B de Steenhuijsen Piters, *Diversity of fields and farmers: explaining yield variations in northern Cameroon.* Disser-tation No. 1892, Wageningen Ag. University, 1995

[13] eg, JH Sanders *et al, The Economics of Agricultural Technology in Semiarid Sub-Saharan Africa,* Johns Hopkins Uni. Press, 1996, for sorghum; IITA, *Sustainable Food Production in Sub-Saharan Africa: IITA's Contribution,* IITA, Ibadan, Nigeria,1992 for maize.

[14] C Reij and A Waters-Bayer. Farmer Innovation in Africa: *A Source of Inspiration for Agricultural Development,* London: Earthscan, 2001; P Richards, "Toward an African Green Revolution: An Anthropology of Rice Research in Sierra Leone", In, AE Nyerges (ed.), *The Ecology of Practice: Studies in Food Crop Production in Sub-Saharan West Africa,* India: Gordon and Breach Publishers, pp. 201-252, 1997.

[15] BDS Salasya *et al, An Assessment of the Adoption of Seed and Fertilizer Packages and the Role of Credit in Smallholder Maize Prod-uction in Kakamega and Vihiga Districts, Kenya,* CIMMYT and KARI, 1998.

[16] See www.etcgroup.org and www.grain.org.

[17] P Richards and G Ruivenkamp, *Seeds and Survival: Crop Genetic Reso-urces in War and Reconstr-uction in Africa,* Rome, Italy: IPGRI, 1997.

[18] TAC, Report of the Fourth External Programme and Management Review of WARDA, Mid-Term Meeting, Dresden, Germany, CGIAR, 2000, p xvi.

[19] L Harrington, "Diversity by Design: Conserving Biological Diversity Thro-ugh More Productive & Sustainable Agroecosys-tems". In, *Swedish Scientific Council on Biological Diversity, Bio-Diversity and Sustainable Agriculture,* Ekenas: Swe-den, Mexico: CIMMYT, 1996.

[20] SMIP, *New Horizons for Research Partnership: the SADC/ICRISAT Sorghum and Millet Improvement Program,* 1999, www.cgiar.org/icrisat/text/research/networks/gnet5

[21] J Smith *et al,* "The Role of Technology in Agricultural Intensification: The Evolution of Maize Production in the North-ern Guinea Savanna of Nigeria", *Economic Devel-opment and Cultural Change* 42(3): 309-341, 1994; CIMMYT Review (various yrs).

Researchers are perhaps less concerned by the loss of field diversity because they have been able to store the diversity they need and want in centralised gene banks. This is not done conspiratorially, but inadvertently when researchers are schooled in reductionist science to believe that they can devise appropriate improved varieties that will meet all needs of all farmers and environments for all time. The resources at the gene banks are available to commercial breeders, but not to the communities who have long (but invisible) investments in those seeds. More recently gene banks have gained increased prominence, as private biotechnology companies view them as sources of raw materials to be strip-mined for the value of their genes for genetic engineering. Yet private companies – who, unlike farmers, have the means to access farmers' innovations enclosed in such repositories – are very unlikely to seriously address the needs of the poor (see box on p 31).

In conventional research and evaluation, new seeds are promoted to uniformly replace ones, and this is often depicted as a one-time event. The mentality is that of *"command and control,"* yet without the omniscience, the rationality, nor the capacity to determine optimal arrangements and actions for all actors. But farmers need to be able to constantly change, innovate, update, and adapt the varieties they use according to their changing biophysical and socio-economic realities. Hence, access to a diverse cache of human skill and knowledge, and a healthy pool of genetic resources is vitally important. Varietal development should be seen as a continual process, not a one-off 'out with the old, in with the new' kind of transfer. Farmers must take the lead and be involved at each stage.[23]

When the locus of innovative energy is moved from farmers to distant researchers in research stations, farmers and their innovating networks lose access to genetic resources, and are left with the varieties that researchers develop. Vital resources and power for responding, experimenting, innovating, coping, and diversifying are removed from farmers' control and placed in the hands of unaccountable, unrepresentative and unresponsive personnel. Giving privilege to formal centralised systems like these effectively disempowers farmers and their social networks.

There is a fundamental issue of flexibility and self-sufficiency here. If farmers are used primarily in utilitarian ways to extract information (eg about which characteristics of a variety are important), they are placed in a relationship of dependency. Increasing the list of crop breeding criteria from, say, three to eight variables, as is sometimes done, is not enough to meet everyone's needs. It is not simply that mainstream researchers fail to understand different farmers' different priorities, they also are blind to the diverse mechanisms by which farmers understand and undertake selection and prioritisation. Farmers do not just need better products, they must be able to confront new challenges (like a new pest or disease) as they arise, independently of researchers who will not always be there, and this involves coordinating amongst themselves. What is needed is to empower farmers and strengthen their networks to be able to cope, adapt and anticipate, rather than relying on researchers as the sole source of innovation.

To be productive, farmer-innovators need to have access to genetic repertoires from which they can draw, to take advantage of variation in biophysical and socioeconomic conditions and to protect against unexpected shocks. Broad *access* to appropriate genetic resources – judged according to multiple linked criteria by diverse farmers – is key to meeting the needs of farmers. This can be done through decentralised networks with farmers in the driver's seat, and with scientists and extensionists as facilitators and in other supportive roles.

This article is based on the manuscript for Aaron deGrassi and Peter Rosset's forthcoming book, ***A New Green Revolution for Africa? Myths and Realities of Agriculture, Technology and Development*** *(Food First Books, 2004).*

22 TAC, *Report of the Fourth External Programme and Management Review of WARDA, Mid-Term Meeting,* Dresden, Germany, CGIAR, 2000, p 10.

23 See for example E Weltzien *et al*, "Technical and Institutional Issues in Participatory Plant Breeding", *Working Document No. 3*, Cali, Colombia: CGIAR Systemwide Program on Participatory Research and Gender Analysis for Technology Development and Institutional Innovation, p 14, 2000.

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