

From technology transfer to innovation systems: sustaining a Green Revolution in Africa

Smallholder agriculture is the core contributor to agricultural production in most African countries and the main driver for food security, poverty reduction and growth. But productivity remains desperately low with limited use of improved inputs (except where boosted by subsidies) – compounded by volatility in climate and markets.

Science and technology is widely seen as essential in turning African agriculture round. The Comprehensive African Agriculture Development Programme (CAADP) Pillar IV is leading moves to revitalise, expand and reform Africa's agricultural research and development

effort.¹ Investments are being made by national governments, donors and private funders in (mainly international) research institutions to develop improved seeds and soil fertility technologies for a Green Revolution in Africa. Public and, increasingly, private sector delivery systems are gearing up to deliver these technologies to farmers. Within integrated agricultural research for development (IAR4D), focus is moving beyond the farm-gate to credit, markets and value-addition.² Farmers are being involved earlier in the development process – the effectiveness of agricultural technology generation and dissemination institutions seen

as depending crucially on relevance and responsiveness to farmer needs.

Yet 'market-led technology' approaches – aimed mainly at high potential agricultural areas – face serious challenges in delivering a broader-based inclusive agricultural revolution.

This policy brief draws on research findings by Future Agricultures and asks:

- Are there options outside conventional institutional routes that bring alternative expertise – particularly farmers' own innovation experience – into revitalised innovation systems that cut across public, private and farmer-led processes?
- How can agricultural innovation systems be made to work for poor people in expanding market access and enabling rural innovation?
- Are there alternative pathways for more sustainable and socially-just development, and what obstacles – political-economic as well as technocratic – need to be overcome to pursue these?

Agricultural Innovation Systemsⁱⁱⁱ

To survive and be effective in an ever-changing world, a continuous process of innovation is required. How agricultural innovation takes place and what is preventing it is fairly well understood:

- Innovation requires knowledge from different sources, including the users of that knowledge.
- Different sources of knowledge interact to share and combine ideas.

- Interactions and processes are usually context-specific.

- Each context has its own behaviour shaped by culture, politics, policies and power.

Agricultural Innovation Systems^{iv} (AIS) – borrowed from business and industry – represent a shift from technology delivery mode to capacity-strengthening – specifically the capacity to innovate. AIS has evolved from familiar approaches: Transfer of Technology (ToT) and Agricultural Knowledge and Information Systems (AKIS) (Table 1). In ToT models (classic National Agricultural Research Systems), scientific research is seen as the sole supplier of knowledge within a scientist-controlled environment (narrow innovation process). In the AKIS perspective, innovation is generated within a knowledge system made up of multiple actors across research and extension interacting and making different contributions to generating knowledge.

In Agricultural Innovation Systems, the aim is to create better opportunities for small farmers to innovate – rather than trying to introduce innovations. The innovation system goes beyond the farmer and researcher to the private sector, technology delivery agencies and other actors in the broader institutional and policy environment. AIS encompasses participatory rural approaches (PRA), public-private partnerships (PPP), local innovation and so on. Rather than being simply a new brand of innovation, agricultural innovation systems can be looked at as 'innovation diversity'.

To mobilise innovation diversity and create space for further diversity to emerge, policy and institutional change are needed. Strengthening AIS is about ensuring conditions to nurture eclectic approaches to innovation exist, and that competing interests – scientists, policy-makers,

Table 1: Evolution of agricultural innovation capacity development frameworks

Defining Features	Transfer of Technology (ToT)	Agricultural Knowledge and Information Systems (AKIS)	Agricultural Innovation Systems (AIS)
Purpose	Planning capacity for agricultural research, technology development and transfer	Strengthening communication and knowledge delivery services to rural people	Strengthening capacity to innovate throughout the agricultural production and marketing system
Actors	Research Institutes, Agricultural Universities, Extension services, farmers	Research Institutes, Universities, Extension Services, Farmers, NGOs and entrepreneurs	All public and private sector actors involved in creation, diffusion, adaptation and use of all types of knowledge in production and marketing
Outcome	Technological invention and technology transfer	Technology adoption and innovation in agricultural production and marketing	Combinations of technical + institutional innovations throughout production, marketing, policy research and enterprise domains
Organising principle	Using science to create knowledge: invention-driven	Accessing agricultural knowledge: invention-driven	Creating conditions for social and economic change; innovation-driven
Mechanism for innovation	Transfer of technology	Interactive learning	Interactive learning
Market integration	Nil	Low	High
Role of policy	Resource allocation, priority-setting	Enabling framework	Integrated component and enabling framework
Nature of capacity strengthening	Infrastructure and human resource development	Strengthening communication between actors in rural areas	Same as NARS and AKIS + strengthening: linkages and interaction; institutional support for linkages, learning and innovation; enabling policy environment

Source: Hall (2009)^{vii}

consumers and entrepreneurs - join forces to continually adapt institutions and policy conditions for innovation. This means:

- Finding ways to mainstream collaborations (such as special projects) between research institutions, users, entrepreneurs and other sources of technology - overcoming deep-seated attitudes and practices in public and private sectors.
- Supporting participation and interaction among stakeholders – innovation can emerge when different stakeholders come together on platforms to decide on concerted action towards a common objective (e.g. Harambee in Kenya)^v.
- Strengthening a facilitation role for the public sector^{vi} – providing mechanisms to support effective interaction between small-scale farmers (particularly those not reached by

extension and markets) and other actors - the market alone is not sufficient.

Enabling Rural Innovation – Poor people and markets^{viii}

Enabling Rural Innovation (ERI) is an innovative approach for linking smallholders to markets developed by the International Center for Tropical Agriculture (CIAT) and partners in Uganda, Tanzania, Malawi, Zimbabwe, Kenya, Mozambique, Zambia, Rwanda and DR Congo. Agricultural markets can play important roles in reducing poverty in poor economies. But markets can fail the poor and marginalised groups, especially women – due to social, cultural and other constraints. The approach incorporates specific strategies to promote participation by women and the poor, and builds their capacity to engage with markets. The aim is to create an entrepreneurial culture where farmers ‘produce what they can market, rather than trying to market what they produce’.

Enabling Rural Innovation: Case study of Potato Farmers’ Group, Uganda (CIAT)

Nyabyumba Farmers’ Group, Kabale District was formed in 1998 with 40 men and women members. Supported by Africare (an international NGO) the group focused on producing improved potatoes from clean seed provided by the National Agricultural Research Organisation (NARO). In 2000 they formed a farmer field school to increase knowledge on potato production. Equipped with skills for producing high-quality potatoes in large quantities, the group decided to go for increased commercial sales. Africare, NARO, the Regional Potato and Sweetpotato Improvement Network in Eastern and Central Africa (PRAPACE) and CIAT provided training in identifying and analysing market opportunities and developing a viable business plan for the potato enterprise. Nyabyumba group identified Nandos, a fast-food restaurant, and local wholesale markets in Kampala and set up committees to plan and manage their production and marketing processes. To provide a constant supply, the farmers have a staggered planting system, producing 5-10 tonnes per month, selecting the best quality tubers for the Kampala markets. The group has a steady income and are investing in a store and irrigation equipment to expand the business. Success is based on: long-term support from research and development partners, improved knowledge in production and marketing, and collective marketing.

ERI uses participatory research approaches to strengthen capacity of research, extension and development partners and communities to access and generate technical and market information for improved farmer decision-making. It seeks to foster effective public-private partnerships, horizontal and vertical links between networks of farmer organisations and research and extension service providers.

Selection of products and business options involves market opportunity analyses based on demand and profitability – which tend to favour high risk options - and assessment of the level

committee undertakes market studies on behalf of the group. Participatory market research builds skills of farmers to analyse markets and consolidate relationships with traders to negotiate better prices. Enterprise selection is based on sound technical and economic information as well as community criteria. Business plans of the best enterprise options are designed and tested for collective marketing. Gender sensitive participatory tools and methods build capacity of women and men to evaluate diverse market opportunities and experiment with crops and crop management technologies.



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Women can develop businesses with support across the value chain

of risk a particular client group can undertake. Once the group has selected the most appropriate option, it begins a step-wise approach to developing sustainable enterprises, supported by a community development facilitator. Participatory diagnosis assesses community assets, market opportunities and constraints. An elected enterprise planning

Lessons from the ERI initiative:

- Effective farmers' organisations – FOs are critical in expanding market access, and are important stakeholders in agricultural R&D. Benefits are not equally distributed within FOs – men, educated people and group leaders

benefitting more than women and the less educated.

- Market linkages benefit women – participatory approaches linking farmers to markets increase the bargaining power of women, increasing income, social capital, shared decision making, skills in market analysis and experimentation, and leadership. Choice of enterprise and the farmer-to-market approach influence women’s degree of control.
- Barriers to market access for the poor – these include: low asset base, lack of market information, weak institutions, difficulties of capturing benefits from value addition, low involvement of the private sector and commercial relationships. Alternative ways are needed to link women and hard-to-reach farmers with market opportunities.
- Research linkages – sustaining increases in productivity necessitates strong linkages with research. Pay-offs are higher when agro-enterprise development is linked to research

which addresses bottlenecks along the value chain – e.g. produce quality.

- Need for policy options – rigorous assessment of economic and policy factors influencing the functioning of input and output markets is a critical missing element. Research on policy options for promoting engagement of the poor in markets is urgently needed.

Extension to support innovation: Zooming-in Zooming-out^{ix}

Extension modes and methods of delivery have seen a shift towards supporting farmer innovation-joint learning sessions to understand core principles (Farmer Field Schools) and farmer-led trial processes (Participatory Plant Breeding). New media and IT technologies support learning – cellphones and texts transfer real-time market information, GIS provides site-location support, mobile testing systems enhance diagnostics of soils, pests and diseases, and video and rural TV/radio encourage exchange of ideas.

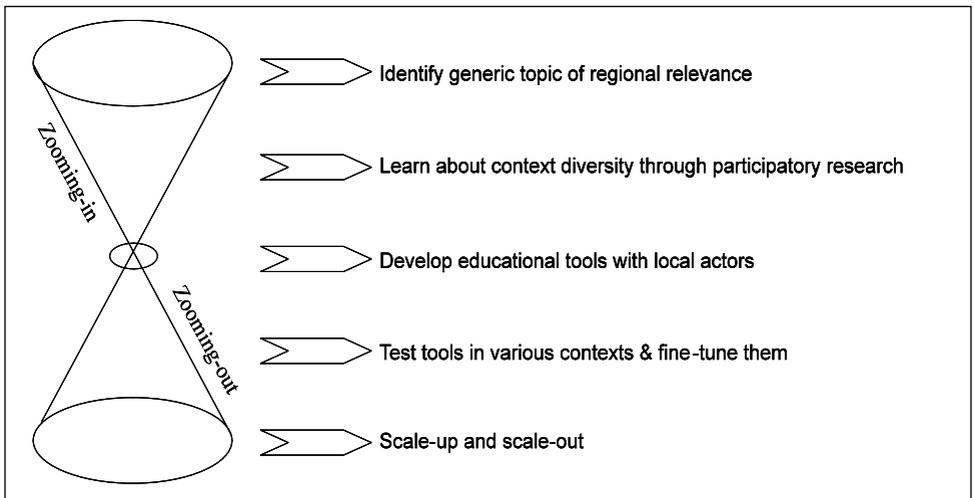


Figure 1: Zooming-in zooming-out: scaling-up sustainable innovations

Zooming-in zooming-out (ZIZO) is an approach for communicating agricultural innovations with the rural poor developed by AfricaRice Center (WARDA). It draws on Rhoades' principle that farmers need fresh ideas and to be presented with underlying scientific principles, rather than ready-made technologies, and provides guiding principles to produce high-quality farmer education tools that are locally appropriate and regionally relevant.

ZIZO starts with a broad stakeholder consultation to define regional learning needs (Figure 2). Then communities talk through their ideas, knowledge and innovations around the chosen topic (zooming-in). Educational videos are produced in close consultation with end users (and farmers who have been involved in participatory research) - building on the principle of communicating ideas. When draft videos are shown to further villages (zooming-out) further innovation is identified and adjustments made. If the topic is regionally relevant, multiple service providers will be ready to incorporate the videos into their own programmes. Some facilitation may be required such as networking and translating into local languages.

Based on a few well-selected innovations from farmers and researchers – in this case around management of rice - and merged with scientific knowledge, video has been able to explain underlying biological and physical principles. The more these principles resonated with what farmers already know and did, the more useful it becomes. Facilitation helped increase farmer experimentation with sustainable technologies. Ideally farmers engaged in participatory research should take part in developing videos. The relevance of the technologies plus a creative communication approach has led to videos being scaled up to millions of farmers through both facilitated group discussions and non-supervised learning,

such as videos in markets and mass media. Farmers can learn by watching other farmers on video if the programmes are well planned and simply structured. The ZIZO approach enhances efficiency and effectiveness of rural learning systems.

Policy implications

- Experiential learning can be stimulated in many ways and – given limited resources in national extension systems – more attention should be paid to unsupervised learning.
- Changes within International Agricultural Research Centers are needed to enable them to: build national research and extension capacity to develop high quality, learner-centred educational tools and strategies; facilitate processes, mechanisms and institutions to support farmer-centred approaches in technology development and dissemination; and assess the efficiency and effectiveness of uptake methods.
- Linkages between multiple actors in the innovation system need to be strengthened by looking beyond enhancing scientific capacities to learning.

Seed systems – Pathways to an inclusive Green Revolution^{xi}

Significant resources are being channelled into technical, financial and institutional support for crop breeding, market development and input subsidies, in an attempt to replicate the Asian Green Revolution across sub-Saharan Africa. The emphasis is on developing new technologies – primarily new seed varieties, fertiliser and improved soil management - combined with market-based solutions – networks of local small-scale agro-dealers^{xii}. The assumption is that once technology is made

available, constraints on adoption and diffusion can be addressed strategically, prioritising the best-endowed lands and potentially most successful crops, such as rice and maize.

The debate on innovation systems in Africa has focused on overcoming very real technical and market challenges. Political, institutional and social dimensions of designing and implementing a new Green Revolution for Africa have so far been largely absent. Yet given the number of failed attempts at agricultural intensification over the past 40 years, the question is: Why have Green Revolutions not been sustained in Africa?^{xiii} Research by Future Agricultures on political economy dimensions of cereal seed systems underlines a wider set of narratives and pathways to more sustainable, productive agricultural futures.

Seed systems (Figure 3) are characterised by complex interactions of formal sources – breeding, gene banks, commercial companies,

agrodealers and seed aid (the dark cylinders) – and informal sources – farmers selecting, saving, gifting and exchanging own seed, and local markets (the light cylinders). Informal systems supply 50-90 percent of seed in Africa.

Seed security comes from the combination of seed availability, access and quality and depends on effective functioning of the overall system. Green Revolution efforts focus primarily on the formal system – seed quality (through breeding and genetic engineering) and availability and access (through private sector development, facilitation of market channels and support for agrodealers). Informal systems are missing from the agenda - though resilient and productive in many respects (and providing a major opportunity for formal system technologies to link with local innovation). Political economy factors are also absent – yet these influence which elements in the system are prioritised for investment and how they interact, and institutional arrangements

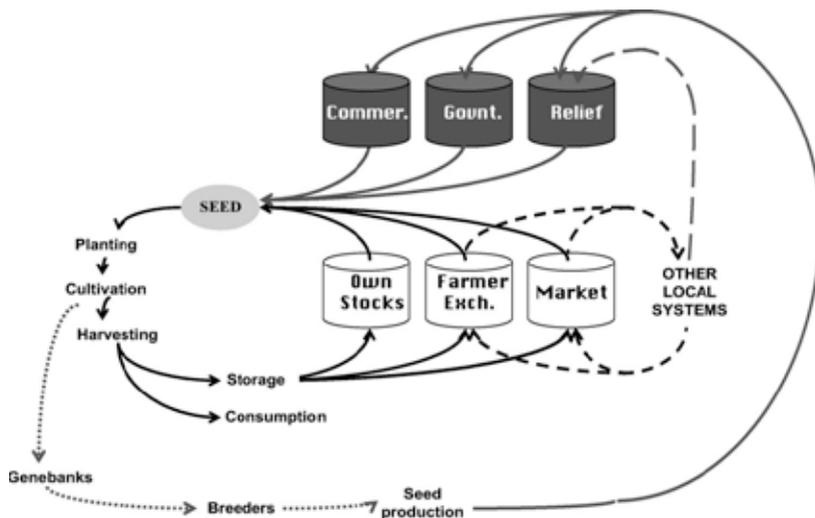


Figure 3: The seed system^{xiv}

governing seed policy and practice. How these factors play out varies from place to place.

In Kenya, where there is a relatively strong private sector and long history of supplying technologies to farmers, public-private partnerships are providing technical support to build a strong private seed sector and agro-dealer networks. However, agro-dealers are concentrated in higher potential areas and lack supportive infrastructure - roads and storage facilities - which increases seed and other input prices, limiting accessibility to many farmers. Making a business out of selling inputs to poor farmers is risky, especially in dryland areas.

In Malawi, maize politics have created a seed industry controlled by internationals offering farmers a narrow range of products. Since 2005 input support programmes – supported by an alliance of government, donors and seed companies – have improved the food security situation, but subsidies are a major drain on government resources and have become highly politicised. The private sector has over time been incorporated into the programme, with global seed companies providing seed in bulk and agro-dealers delivering this through a voucher programme. This has favoured certain enterprises (those with capital), products (hybrid/OPV maize seed) and research priorities (undermining national breeding capacities).

In Zimbabwe, input subsidies have been part of relief and rehabilitation programmes - with government channelling funds through state agents to get improved seed to new resettlement areas, and NGOs focusing on communal areas. These emergency measures mostly by-passed existing seed delivery channels and rely on a few commercial suppliers – potentially undermining the long-term recovery of the sector.

Political-economic interests thus shape Africa's seed systems and are creating certain pathways for a new Green Revolution. But are there alternative pathways which can deliver benefits to wider groups through different means? How can informal seed systems – well suited to many African agro-economic contexts – be galvanised? And how can local expertise be mobilised, together with external sources of technological innovation and business skill, in new ways? High-end genomics techniques linked with farmer innovators by internet and cellphone offer a potential for new alliances for open-source low-cost innovation – less easily captured by elite research and business interests. Providing options for groups with diverse local circumstances, needs and preferences – agroecology-based technologies – is critical. Other pathways are: conventional technologies for promoting production combined with sustainability;^{xv} minimising external inputs and environmental impacts;^{xvi} maintaining bio-cultural diversity of seed systems;^{xvii} and sustaining locally-based economies and food sovereignty.^{xviii}

A 'rainbow' vision of Africa's new Green Revolution includes mainstream approaches for some settings – e.g. high potential areas – and alternative pathways for others. But some pathways are more privileged than others – with powerful political and economic interests shaping which get prioritised and funded. Africa needs new seeds and technological and market solutions to increase agricultural productivity and growth. Sustaining this means addressing the interests, values and choices that drive innovation through open debate about future options and pathways - about *direction* of technological change, *distribution* of resources, benefits and costs, and changes in *diversity* of technologies and practices.^{xix}

What role^{vi} for Ministries of Agriculture in supporting innovation pathways?

- **Balancing development priorities** – alongside national food security, poverty reduction and increasing production, ministries should focus on improving productivity across entire supply chains
- **Coordinating and facilitating supply chains** – promote investment in processing and marketing as well as development of agricultural production technologies; ensure market information systems are available for farmers to improve decision-making; provide fora to help private interests – including small-scale producers – and government find ways of improving supply chains; promote institutional innovation to support commercial opportunities (seed capital, financial guarantees)
- **Facilitating uptake of technologies** – screen innovations from regional and global sources and adapt best bets to local situations. Where technologies are unaffordable for poor farmers, selective short/medium term support (subsidised inputs, credit) can boost staple food productivity.
- **Regulation** – where facilitation fails regulation may be needed through licensing traders, setting prices.

Key policy findings

- Agricultural Innovation Systems create opportunities for farmers to innovate – rather than delivering ready-made technologies - and need to be supported by facilitating linkages between scientists, policy-makers, consumers and entrepreneurs.
- Small farmers – including women - can enter markets if linked to participatory processes, effective farmer organisations and technical and policy research.
- Extension can promote joint learning and farmer innovation by communicating core principles to farmers using conventional methods and new technologies.

- Alternative pathways and options to securing a sustainable 'Rainbow Revolution' for diverse groups and ecologies need to be placed on the table-beyond just the market-led technology approach.

End Notes

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Small-scale farmers need a range of technology options

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