Growth Research Programme

How extension influences the spread of agricultural innovations in DRC

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Key messages:

1. Small-scale farmers welcome technical improvements for their crops, even in under-developed areas that have recently been ravaged by conflict, such as South Kivu.

2. Existing social networks within communities can be used to spread new ideas, but agricultural extension needs sustained engagement with farmers, not fleeting contact.

3. Empowered farmers can more readily appreciate and take up innovations. Painstaking work by civil society to build the capacity of ordinary farm households to engage with the rest of the community and the outside world pays off.

This brief summarises and sets in context the results of the DEGRP-funded research project *Agricultural innovations: which farmer(s) should we target?* The research investigated the effectiveness of agricultural extension efforts in South Kivu, Democratic Republic of the Congo.

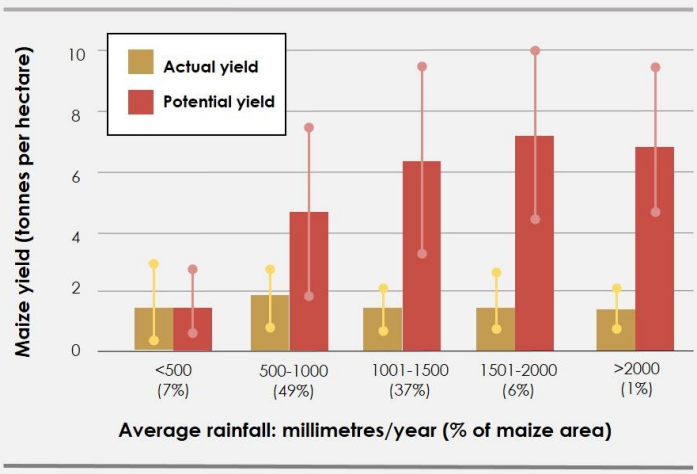
Agricultural interventions in sub-Saharan Africa

Crop yields per hectare are often low on many farms across sub-Saharan Africa. In some cases, low yields reflect poor soil and indifferent climate, but often the yields seen are considerably less than can be achieved by making use of better agricultural technology, whether this be physical inputs such as improved seed varieties, fertilisers, irrigation, or techniques for managing crops, soils, weeds and pests.

For cereals such as maize, average yields in 2012/14 in Eastern and Western Africa were estimated at 1.5 to 1.7 tonnes per hectare: yet by using better techniques it is not hard to achieve four or more tonnes per hectare in places with reasonable rainfall (Figure A).

Making sure that farmers, and especially smallholders, know about the latest productivity-enhancing technologies and can apply them to their fields is therefore a longstanding concern for those interested and engaged in African agricultural development.

Figure A: Yields seen in 2000 and potential yields for maize, sub-Saharan Africa



Note: Bars indicate average yield in each annual rainfall category weighted with maize harvest area. Error bars indicate one standard deviation. Percentages in parentheses indicate the approximate share of maize production area in each rainfall category.

Data source: Actual yield – You et al. 2012; potential yield – author's calculations.

Since the 1950s if not earlier, agricultural extensionists have striven to find the most effective ways to offer farmers useful advice on their crops and animals.

The DEGRP research

Aims

The DEGRP-funded research led by Professor Erwin Bulte from Wageningen University aimed to assess **the impact of agricultural extension services** offered as part of the N2Africa programme in South Kivu, Democratic Republic of the Congo (DRC).

More specifically, the project aimed to assess the effect of the programme's extension of technical advice and products on farmers' crop yields, production, income, and food security.

It also aimed to investigate the processes by which extension information is passed from farmer to farmer, and with what results.

N2Africa programme

The N2Africa programme has been operating in eight countries in Africa, including a site in South Kivu, since 2009. Funded by the Bill & Melinda Gates Foundation and led by Wageningen University, the International Institute of Tropical Agriculture (IITA) and the International Livestock Research Institute (ILRI), the programme partners with local NGOs in rural Africa to encourage smallholder farmers to grow soil-improving legume crops as a means of stimulating their yields in an ecologically and economically sustainable way.

In South Kivu, N2Africa works through six local NGOs to extend packages of technical advice on this issue to smallholders, along with starter packs of fertiliser, improved seed varieties for cassava, soybean, and maize, and legume seed inoculant (see Box A overleaf).

The technical advice offered includes information on: the use of inoculants to boost soybean productivity; crop planting techniques, such as line sowing and seed spacing; use of mineral and organic fertilisers; use of plants to combat erosion; soybean processing; harvest management; and seed conservation. This advice is mostly disseminated via farmer training and plot demonstrations.

Country context

South Kivu is in the far east of the Democratic Republic of the Congo (DRC), where the country borders the Great Lakes of central Africa (Figure B). This largely agrarian region is relatively undeveloped, with high rates of poverty and food insecurity. Severe conflicts arose in 1996–97 and 1998–2003, with hostilities persisting to the present. War destroyed crops, livestock, and homes, and thousands fled to escape the fighting.

Yet South Kivu has good agricultural potential. Much of the soil consists of fertile volcanic matter, while the region receives plenty of rain (over 1500 mm a year) relatively reliably. Although close to the Equator, most of the province is located at 1,400 metres or higher and so benefits from altitudinal cooling, which prevents the equatorial high temperatures from inhibiting crop growth.

Figure B: Map of study area

Source: Google Maps. Red lines mark the borders of South Kivu.

Methods

Two sets of studies were carried out in pursuit of the project aims, comprising a range of methods.

The first set looked at the differing impacts of technical advice and provision of agricultural inputs. Some 92 villages in South Kivu were studied. In 31 villages, participating farmers received N2Africa extension messages and training, plus the offer of seed, fertiliser and inoculum to be sold to them with a 25% subsidy on their actual cost. Another 33 villages received only extension messages. The remaining 28 villages received nothing and were taken as controls. Ten randomly-selected households were **surveyed** in each village before the interventions in mid-2013, then later in late 2014 to see what had changed. Possible spill-over effects from the treated to control villages were investigated by examining what had happened in control villages within one kilometre of the treated villages.

This set of studies also involved **qualitative enquiries**, carried out from October to December 2014 in six villages — one for each of the six NGOs N2Africa works with. Interviews with key informants and with focus groups of farmers, mainly women farmers, were held to investigate how 'contact' farmers – the farmers who first received the extension from the NGOs, and who were expected to share knowledge and inputs with the rest of the community – had been selected and who they were; how much they and farmers they contacted had learned from the programme; and how social relations influenced flows of knowledge and seed from contact farmers to others in the communities.

The **second set of studies** was specifically focused on social networks and how information and fertiliser packs flowed among households in a given community.

In preparation for this set, 40 villages in South Kivu were selected, and a census of all households in each village carried out. The census captured: the basic characteristics of each household; the members' knowledge of fertiliser; and — most importantly — which other

Box A: Boosting agricultural productivity with legumes

N2Africa promotes growing legumes as a way of enhancing crop productivity. Legumes, such as beans, peas, lentils and peanuts, can fix nitrogen in the soil. They capture nitrogen – a nutrient critical for plant growth – from the atmosphere, and fix it in the soil, so that both they and other plants can use it to flourish.

They do this with the help of a particular soil-dwelling bacteria, *rhizobia*, with which they live in symbiosis, the *rhizobia* (which reside on the plant's roots) pulling nitrogen from the air and feeding it to the host plant. When the host plant dies, it releases the nitrogen into the soil around it, acting as a natural fertiliser for other plants.

However, simply planting legumes doesn't guarantee nitrogen fixation. Although *rhizobia* are naturally-occurring in most soils, they aren't always present in high enough numbers to help their hosts capture atmospheric nitrogen. In addition, as there are several different strains of *rhizobia,* each suited to interacting with a particular legume, nitrogen fixation only occurs if the right kind of bacteria are present in the soil. Fixation is also affected by external stress on the plants, such as bad weather, water availability and deficiencies of other nutrients aside from nitrogen.

In these cases, fixation can be stimulated by choosing legumes with a strong natural fixing potential, but above all by treating the seeds to be planted – or the soil they will be planted in – with the correct strand of *rhizobia* bacteria — termed 'inoculant' or 'inoculum' — in advance. Meanwhile other strains on plant growth can be addressed through, for example, irrigation, fertiliser use, and changes to planting and harvesting methods.

households formed part of their social network, either through family ties, being neighbours, or those they met as part of agricultural groups.

Each household could thus be scored for number of contacts they had, so that households could then be defined by their centrality to social networks: central, middling or isolated.

Games were then played to explore levels of trust and community-mindedness, where the players were of various different levels of centrality

Another study **compared the centrality of households** as measured to community choices of who should be appointed as contact farmers. Extension services inevitably have to choose to work with a selection of farmers, rather than the whole village, so choosing those who are most likely to pass on new ideas matters.

A final study in the set saw the research team **distribute fertiliser packs** through selected farmers who were then expected to pass on the packs, with messages on use of fertiliser, to three farmers, who in turn would be expected to distribute to another three farmers. In this study, the selected farmers were variously either socially central, or isolated, to see what difference this made to diffusion.

By carrying out this variety of studies, with differing aims and methods, the researchers built up a rich picture of agricultural extension impacts and processes than had a single study been conducted.

Findings

Impact of N2Africa programme on knowledge, yield, and food security

The **quantitative survey** [Leuveld et al. 2017] revealed some welcome changes: farmers who had been in contact with the N2Africa programme knew more about crop management, fertilisation and use of seed inoculants. They obtained higher bean yields – worth about US$40 a hectare – and felt less anxious about their food security. The higher yields, however, were not related to any significant increase in use of fertiliser or other inputs: they came from better crop management.

Little evidence was seen of consistent differences in effects by gender of household head, or by security of land tenure. Villages distant from markets seemed to value information more than those close to markets: perhaps because the better-connected villages could buy and apply more inputs, while more remote settlements had to make do with their local resources, so that technical knowledge was correspondingly more valuable.

While some knowledge did spill over from treated to nearby untreated villages, this did not seem to have any impact on practice or production in the latter. That was probably because the messages being transmitted were quite complicated: they were probably only going to be internalised by those who had not only heard the messages, and seen the demonstrations, but who had also tried out new techniques on their own fields.

Sharing behaviours of contact farmers

The **qualitative studies** on extension impacts [Kendzior et al. 2015] showed that all six NGOs working with N2Africa adopted a similar model to disseminate extension advice, first passing information to contact, or 'master' farmers, who were then expected to share knowledge and any inputs with satellite farmers. Although the NGOs thought that this model worked, not surprisingly there were reports that a few master farmers had hoarded inputs, or only allowed others access in return for labour.

Asking about seed was revealing: most farmers saw seed as a community resource. If asked for seed, they said, one was usually obliged to share with others. That was not necessarily entirely altruistic: sharing seeds ensures the community has a safe supply of seed of a particular variety, even if the original seed owner loses their harvest.

Farmers tended to share with family, neighbours and others close by. Seed was given with varying expectations, from immediate cash payment, or in

return for work on fields, to forms of deferred reciprocity, to pure gifts.

The villages were egalitarian in some ways: farmers did not see hierarchies among themselves as farmers. Indeed, they preferred to share with fellow members of farmer groups, rather than through other community structures such as the churches and official chiefdoms, which were seen as hierarchical.

While knowledge was shared, people were reluctant to volunteer knowledge: that, they said, would be too forward, too arrogant, and meant carrying some responsibility for someone else's harvest. If asked, one shared; but only if asked.

The farmers interviewed appreciated and shared messages on: line sowing (even those who had not seen demonstration plots picked up the idea after seeing it applied on neighbours' fields); on producing and applying compost; on the benefits of soybean, valued for its protein; and on how to process it.

The farmers also reported that they could see that the seed inoculum provided by N2Africa was working, but few understood how it worked. Manufactured fertiliser was appreciated, but few farmers used it on their field crops owing to cost or unavailability. They understood the economics, however: fertiliser was almost always applied to small plots for planted with more valuable crops such as aubergine, cabbage, tomato, as too was pesticide.

In addition, those NGOs that had encouraged participation, built capacity locally, and empowered women, seemed to get better spread of innovations. The farmers they worked with were more confident in discussing their experiences both with the researchers and among themselves.

The interviews revealed that agronomists from the NGOs were also enthusiastic: they wanted more contact with the research station and the innovations that were being trialled and developed.

Role of social networks

What did the studies that explored **social networks** find? [Hofman et al. 2017a, b, Ross et al. 2017] The households most central to networks tended to be male-headed, with more years of schooling, and were long-term residents rather than recent migrants. [1]

The experimental games played showed that players from households more central to social networks shared more and were more cooperative; but the differences between them and the more isolated players were small. When observed, players tended to be more generous towards others, suggesting that reputation stimulates cooperation.

When residents were asked to nominate who they thought should be contact farmers, they chose people who were central to networks and seen to behave pro-socially. Those chosen tended to be 'male, older, head of larger household, educated, in a community leadership position, and of greater wealth.' In other words, choices were based on social characteristics: agricultural proficiency or expertise was not considered.

When the researchers used network analysis to identify who might make the best contact farmer so as to maximise contact with other households, little difference was seen to the community choices.

In the study on fertiliser pack distribution, the first contact ambassadors did indeed distribute their packs, but only 20% of the second-stage contacts then passed on the packs they were entrusted with to other farmers. The effect was a small increase in the use of fertiliser. This did not depend on the centrality of the contact: indeed, choosing more isolated households led to quicker and slightly wider distribution of packs.

Contact farmers tended to share with those close to them, especially fellow members of farm groups. Socially isolated households tended to share with both other isolated as well as central households, but the latter tended not to share

[1] Owing to conflict, around one third of households in the villages were recent migrants who had fled from their original homes.

with those on the periphery of their social networks.

Attenuation of effects, however was strong: '*First stage ambassadors used chemical fertiliser in about 40% of the cases, while those who receive from first-stage ambassadors the adoption rate drops 8% points (32%). For those receiving from the second stage ambassadors the percentage is 20%. For non-receivers it is 10%.*' (Hofman et al. 2017b)

What does this teach us?

Resilient farmers

South Kivu is striking for the context: the scene of almost a decade of some of the worst civil war seen in modern African history. Despite this dreadful past, as more peaceful times are established, farmers are once again growing their crops and looking for ways to improve their production. The programme seems to have had some success not least because active farmers and farmer groups are highly receptive to innovations that promise higher yields, larger harvests, more food and income.

Functioning communities and NGOs

The programme has been able to operate since local communities are functioning, despite the enforced dislocations of war. Moreover, NGOs are working with them to help improve lives. Although these studies were not directly assessing the social fabric of the rural areas, neither the programme nor the research could have taken place without functioning communities and NGOs.

Community selection of contact farmers works — up to a point

The network studies show that community selection of contact farmers leads to those centrally placed in social networks being chosen. This ensures that people with good social networks and some influence are the ones selected to spread information about innovations.

That said, it seems that centrally-placed individuals may not be the best persons to interact with more isolated households. If the aim of programmes is to reach a broad spectrum of farmers, and those likely to have low incomes, then additional effort will need to be made to select contact farmers from less well-connected households.

Agricultural extension requires protracted engagement

When technical messages are not that simple and straightforward, which so often applies to agricultural innovations, then attenuation of messages from the first provider to subsequent hearers is strong. This suggests that, to succeed, agricultural extension work needs prolonged and regular contact with farmer groups, to accompany farmers as they try out innovations, then come to incorporate what they see as beneficial into their practice. It is not a question of delivering and message and then leaving the farmers to it.

Building social capacity pays off

Those NGOs that had encouraged their clients — farmers, and women in particular — to develop their agency through raising their skills in team work and leadership, were most effective in agricultural extension. It is not always clear that the painstaking work of some NGOs to build capacity with individuals and groups in villages is worth the cost. The little evidence that we have in this case, however, suggests that it does pay off.

Multi-stranded research yields richer insights

The studies reviewed here inherently exhibit a tension between the demand for the internal rigour of the studies, and the desirability of understanding the detail of process and the importance of context. In this case, by using a variety of methods across a series of studies, the research team has created a richer picture of agricultural innovation in South Kivu than they might have, had all the resources been focused on a single question or method.

Randomised controlled trials can be powerful in establishing causality, but not only do they require considerable resources; they may also miss out on aspects of the context that allow appreciation of the external validity of the results. In this case, the temptation to put all the eggs into this basket has been resisted, to good effect.

Not all of the studies carried out have produced equally useful insights. That is to be expected: tests of some hypotheses will produce indistinct results. That happened here: the games to look at trust and cooperation did not necessarily reveal much. That was always a possibility. This is one more reason to favour research that pursues more than one line of investigation.

Policy implications

The research yields a number of messages for policymakers, of which the most important are:

- Farmers are interested in new ideas, so long as they can see that they produce results. This applies even in areas of considerable poverty that are recovering from conflict, such as South Kivu. Agricultural extension, done effectively, is valued and useful.
- Training trainers and thereby using social networks to help diffuse new technical ideas can be effective, although engagement with farmers need to be sustained, since some technical innovations require hands-on learning by farmers.
- Building the capacity of ordinary people to engage with ideas and actors from outside of the village pays off sooner or later. The returns to such work are not always immediately apparent, but empowering citizens can help all manner of development interventions.

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