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ENHANCING FARMERS' ORGANIZATIONAL AND EXPERIMENTATION CAPACITIES FOR SOIL FERTILITY MANAGEMENT IN SMALLHOLDER CROPPING SYSTEMS IN VHEMBE DISTRICT OF LIMPOPO PROVINCE IN SOUTH AFRICA.

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ABSTRACT

The JOLISAA project analysed a number of multi-stakeholder innovation cases in smallholder agriculture in Benin, Kenya and South Africa through a Collaborative Case Assessment process. The overriding assumption was that a comparative analysis of wide ranging innovation experiences may provide useful insights into the way that innovation processes are triggered and unfold in smallholder agricultural systems. One of the cases investigated in South Africa was from Limpopo Province. This was a project-based innovation processes, initiated to redress how agricultural and social development in rural communities should be addressed through the adoption of the Participatory Extension Approach (PEA). The approach focused on the reorientation of mindsets in Limpopo Department of Agricultural, which were still founded on the teaching of linear transfer of technology models, and where farmers were approached with a believe that extension have all the answers to farmer problems. Participatory Rural Appraisal methodologies were used to interview smallholder farmers and key informants.

It was revealed that this was a case of an innovation bundle where the main innovation was an institutional innovation, with the introduction of PEA through the GTZ/BASED program. The aim was to broaden agricultural service and extension delivery to smallholder farmers in the Vhembe district. In the unpacking of the soil fertility management innovation it was revealed that the innovation consists of a number of innovations, which include technical and organisation innovations. The GTZ/BASED program trained some 700 extensionists in the PEA methodology, capacitating them to facilitate technical innovations amongst smallholders in one of four technical areas. A total of 397 villages were eventually served. The extensionists specialising in soil fertility management teamed up with a local university to redress a severe decline in soil fertility in two smallholder irrigation schemes, Rammbuda and Mphaila. Together with farmers they experimented with innovative ways like green manuring with forage legumes. These technical innovation processes created capacity amongst smallholders that triggered spontaneous farmer-initiated experimentation and innovation processes to improve smallholder farming systems and livelihoods. The key challenge identified was that decisive institutional ownership is required to sustain an enabling environment allowing innovation processes to continue beyond the project phase. The key lesson was that project initiated innovations could trigger farmer innovations and that developmental change strategies should explore such opportunities.

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Key words: Innovation, Soil Fertility, Smallholder Cropping, Participatory Extension Approach.

1. INTRODUCTION

Innovation in the agriculture sector has been usually approached from different theoretical points of view which strive to understand how this process takes place. Innovation can occur through the implementation of an idea, or from new technologies that have their source in either the innovative strength of a company or in research. Innovation is the introduction of a new (or significantly enhanced) product, process, commercialisation method or organisational method within the internal practices of a business, work, place, organisation or external relationships (OECD, 2012). Innovation necessarily involves a certain degree of novelty. It is also important to mention that although research and development are a part of innovation, not all innovations include them. There is growing recognition that innovation encompasses a wide range of activities in addition to research and development (R&D), such as organisational and institutional changes.

The innovation systems approach has increasingly being recommended as a framework for understanding the complexity pattern of interactions among different stakeholders involved in agricultural research and development processes (Engel, 1997; Spielmann, 2005; World Bank, 2006, Hall, Jansen, Pehu & Rjalathi, 2006). It is essential to recognize the importance of innovation transfers and their non-linearity and multi-direction. Innovation is rather a complex integrated system that manifests itself in an interactive process that links actors who act according to market driven incentives, as well as companies and other institutions. These may act according to strategies and rules that are not market driven, such as institutions, research centres and universities. This innovation process led to the development of the national innovations systems because the linear model of technology transfer is out-dated (World Bank, 2006).

The JOLISAA (Joint Learning in and about Innovation Systems in African Agriculture) Project assessed a series of smallholder agricultural innovation cases in Benin, Kenya and South Africa. The project objectives that were pursued, assumed that a comparative analysis of a diverse range of innovation experiences may provide useful insights into the way innovations are triggered and unfold in smallholder agricultural systems. Similarly, that this knowledge could be applied to inform policy processes. This article presents the findings of the analysis of the institutional innovation process that emanated from the development efforts of a partnership between Limpopo Department of Agriculture (LDA) and the German Development Agency (GTZ) to broaden extension service delivery in Limpopo Province of South Africa. The program called Broadening Agricultural Service Delivery (BASED) later became widely known as the GTZ/BASED program and comprised of several focal development areas; including Soil Fertility Management. The project-initiated technical innovation processes seeking alternative ways to improve and manage soil fertility in smallholder cropping systems in Rammbuda (Dzimauli village) and Mpaila (Luhada village) in the Vhembe District were facilitated. The participation of smallholders in on-farm experimentation built capacity that lead to spontaneous farmer- initiated innovation processes to improve smallholder farming systems, livelihoods and a social innovation to reduce the number of meetings and the time away from their farming enterprises.

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2. RESEARCH METHOD

The JOLISAA project was funded by the European Union (EU) and conducted under the international leadership of the International Centre for Agricultural Developmental Research (CIRAD) in France. The JOLISAA project consists of two distinctive but complementary phases, namely the first phase of the project produced an inventory of 39 agricultural innovation cases. The aim was to capture and assess a diversity of multi-stakeholder agricultural innovation experiences involving smallholders and to scrutinise them according to a common framework. Specific selection criteria were developed to narrow this down to 11 cases and to finally select three cases that were assessed through a Collaborative Case Assessment (CCA) process during 2012. The CCA process involved the purposefully selection of cases to better understand how these innovation processes have unfolded and the roles that the different stakeholders have played.

In Limpopo Province Participatory Rural Appraisal (PRA) methodologies like semi-structured interviews and focus group discussions were applied to engage smallholder farmers and key informants to capture how innovation processes unfolded to improve soil fertility in cropping systems in two smallholder irrigation schemes. This was followed by multi-stakeholder workshops where feedback on findings was critically discussed by farmers and the research team. Several stakeholders collaborated at different stages and levels to contribute to the shared focus and collective finding of innovative ways to improve and manage soil fertility in the smallholder cropping systems. Secondary data sources such as GTZ/BASED reports and assignments for tertiary studies were consulted. The stakeholders selected for the study all participated in the original innovation process when it started in 1998 (Table 1).

Table 1: Stakeholders interviewed during the CCA process

Stakeholder groups	Number of interviewees	Methods used
LDA/PEA • PEA BASED facilitators	 2	Individual interviews
Rammbuda irrigation scheme • Farmer experimenters	 4	Group interviews and Venn diagrams
Rammbuda irrigation scheme • Farmer non-experimenters	 3	Individual interviews
Rammbuda irrigation scheme stakeholders • Livestock owner • Tractor contractor • Irrigation scheme members	 1 1 1	Group interview and Venn diagrams with three stakeholders
Mphaila Village • Green manure experimenters	 3	Individual interviews
Mphaila Village • Winter maize experimenters	 2	Individual interviews
• Members of Mphaila Local Traditional Council	2	Group interviews and Venn diagrams
• Inorganic fertilizer farmer experimenters	4	Group interviews and Venn diagrams

Under the GTZ/BASED program Participatory Extension Approach (PEA), previously developed in Zimbabwe, was adopted to facilitate change of mind-sets in Limpopo Province. PEA is an action research/learning approach that emphasizes the development of facilitation capacities of extension staff to manage systemic change, while simultaneously developing an inclusive community based interventions to strengthening local organisational capacities of

farmers and promoting farmer experimentation, joint learning and sharing to address problems and challenges collectively identified (Hagmann, Chuma, Murwira & Connolly,1988). The soil fertility management (SFM) intervention, which was the focus of this JOLISAA Project CCA assessment, was one of the focal areas that were identified through participatory and joint learning processes. The other focal areas were smallholder livestock, animal traction, small scale maize seed production and soil and water conservation.

The participatory SFM intervention was piloted in the villages Dzimauli (Rammbuda irrigation scheme) and Luvhada (Mphaila irrigation scheme) in Vhembe District of Limpopo Province. The two rural villages, Dzimauli under Mutale Municipality and Luvhada under Makhado Municipality, formed the geographical boundaries of the study area (Figure 1).

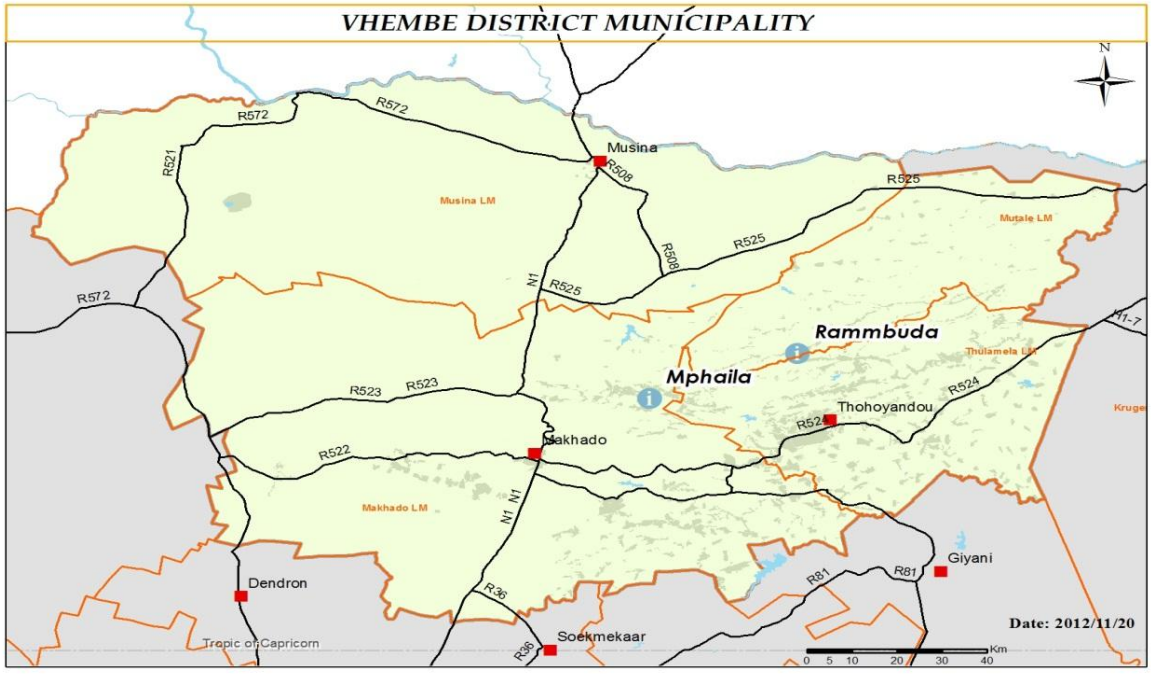

Figure 1: Vhembe district showing the two smallholder irrigation schemes Rammbuda and Mphaila

These two irrigation schemes were selected for the study since the majority of the farmers in the study area practice small scale farming. The smallholder irrigation schemes at Rammbuda covered a total area of 102 ha, while at Mphaila an area of 70 ha was under irrigation. Every farmer-member of the irrigation scheme has access to at least one hectare of irrigation land, which is allocated to them by the Local Traditional Authority through a tenure system of 'Permissions to Occupy'. The irrigation scheme at Rammbuda consisted of 33 male and 61 female members, while the gender split at Mphaila was 57 males and 4 females. Access to external inputs like fertilisers, seed and pesticides is limited.

Vhembe district is characterised by extensive commercial livestock farming and smallholder cropping systems that include vegetables like spinach, cabbage, nightshade leafy vegetable, tomatoes, groundnuts, sweet potatoes, green and dried beans. Maize (a staple food for many in the district) is forming a large proportion of households grow (green and dried maize).

3. INNOVATION PROCESS

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The soil fertility management innovation, when it was unpacked revealed that it consists of a number of different types of innovations. This could be seen as an innovation bundle. What started off as an institutional innovation with the introduction of PEA in Limpopo Province was supported by technical and organisational components.

3.1 Institutional innovation

The institutional innovation process comprised of the development and adoption of the PEA approach in Limpopo Province. The PEA approach was concerned with how do smallholder farmers learn within their perspective and what could be the role of extension advisors be (Hagmann, 1999). The primary trigger at institutional level was a drastic transformation in the international view about how agricultural and social development in rural communities is perceived and how institutional support systems should be structured and operated. Enabling communities as drivers of their own development became a major focus for participatory development efforts. The approach focused on reorientation of mind-sets in LDA, which were still founded on the teaching of the linear Transfer of Technology (ToT) approach, towards a more human perspective and the social and behavioural sciences. The first challenge to the LDA leadership and extension staff was to shift their paradigm radically in terms of personality and professional attitude. In practice it implied the de-learning of the top-down mode of engaging farmers in the ToT approach. An important phase of the innovation process was to re-orientate LDA leadership and participating extension advisors to no longer approach farmers believing that they have all the answers to farmers' problems, but rather assume a role of a catalyst for social change in the sense of "learning together for change". Central to the process was to instil the value of trying to deal with social dynamics, looking at the service functions required in an innovation system based on solving problems in smallholder farming (Ngwenya, Hagmann & Ramaru, 2009). Facilitation competence to mobilise smallholder communities to better articulate their farming problems and to strengthen local organisational capacities was central to the PEA approach.

In addition to the learning workshops, extension advisors also went through specific technical training workshops in which they learned and deepened in technical issues. A core group of PEA trainers were trained. These trainers thereafter trained and mentored some 700 extensionists in PEA methodologies and facilitation skills during a 22 week on-site and in the field training course. The PEA process focussed on four major technical areas, based on farmer needs: soil fertility management, soil and water conservation, small-scale seed production and livestock production. In order to make the integration of PEA within the extension system, a structure was established to support the process of developing competencies and implementing PEA.

3.2 Technical innovation

The technical innovation unfolded within the GTZ/BASED program, namely Community Soil Fertility Management. It focussed on enhancing the organisational and experimentation capacities of smallholders in the two irrigation schemes to experiment with legume green manure and organic fertilisers like chicken manure as an alternative to commercial fertilisers to improve crop yields. At Rammbuda farmers had existing knowledge of using kraal manure, inorganic fertilisers, chicken manure and compost, while farmers at Mphaila mainly had knowledge about how to make compost and its applications, intercropping maize with legumes and knowledge of resting land for one year or more.

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Exceptionally high rainfall, both in quantity and intensity were experienced during the 2000/2001 rainfall season in the study villages. The noticeable effect of this occurrence was a general decrease in crop yields. The farmers of the study area recorded average maize grain yields of around 10 bags of shelled grain per hectare (or 800 kg/ha) compared to 15 to 20 bags of shelled grain (1200-1600kg) before the decline in soil fertility. Loss of top-soil further reduced grain yields to only four bags (320kg/ha) of maize per hectare.

The soil fertility management innovation unfolded over a relatively long period, from 1999 to 2007. Much time and resources were invested in the mobilisation of smallholder farmers, capacity building to allow farmers to participate as equal partners in the innovation process and the implementation of the participatory problem identification and solution seeking process. Regular participatory meetings were arranged where BASED facilitators took the lead but farmers interactively participated. Farmers were encouraged to share their own thoughts about dealing with the problem of declining soil fertility through probing questions. Value of soil sampling were explained and efforts were put into place to encourage participating farmers to become self-organised which resulted in them contributing own funds for the analysis of soil samples. Farmers also helped with the identification of fellow farmers who could be trained in the methodologies and best practices to collect soil samples.

Regular feed-back meetings were held with farmers to engage them in the interpretation of soil analytical data. The importance of essential elements and recommendations for fertiliser inputs were communicated to farmers in their local language. Before presenting new information on nutrient deficiencies, facilitators brainstormed farmers to help them to understand the nutritional status of their soil by asking the following questions:

- What is the local name of the soil?
- What is the level of nutrients in the soils (low, medium, high)?
- What plant indicators do you see in crops growing in the field and how are they related to the fertility of the soil?

The process that was followed is presented in Figure 2.

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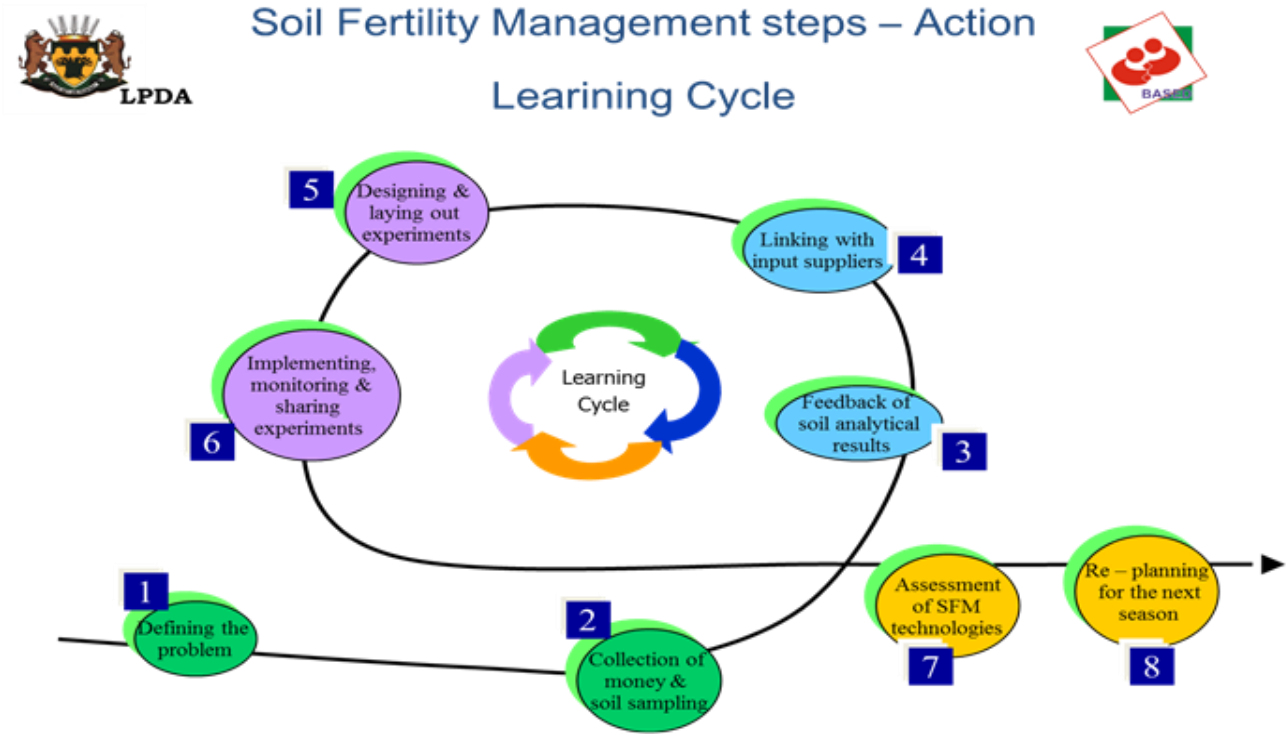

Figure 2: The learning cycle steps and activities in the technical innovation process (Adapted from LDA and GTZ/BASED, 2005).

A range of legumes were evaluated in the on-farm forage legume and green manure experiments to find alternative ways to address the decline in soil fertility and crop yields. These research treatments aimed to evaluate the effect of four different, "best bet" legumes, grown without fertilizer as well as in combination with nitrogen fertilizers (Limestone Ammonium Nitrate - LAN). The following legumes were planted: *Lablab* bean (*Lablab purpureus*), Velvet bean (*Mucuna prurience*), Cowpea (*Vigna unguiculata*) and Sunn-hemp (*Crotolaria juncea*). The effect of the legumes on soil fertility was measured by taking soil samples before and after the trial. The legume green manure at the time of incorporation ranged between 0.4 to 2.7 t ha^{-1} at Mphaila and 2.0 to 6.9 t ha^{-1}at Rammbuda irrigation schemes. The small plot experiments were followed by farm scale trials. Different legumes were tested as green manure to improve soil fertility in farmers' fields at Rammbuda and Mphaila smallholder irrigation schemes. An important aspect of the intervention was to select farmer experimenters where action research could be conducted. Four farmers were identified collectively at each village through a participatory process based on the following selection criteria. (i) the ability to read and write, (ii) being recognised as a committed farmer, (iii) had attended agricultural advisory meetings and sessions, (iv) was willing to share experiences with other farmers and (v) had already paid for soil sample analysis.

There were two components to the experimentation:

- During the first cycle, farmers planted four different legumes on crop land scale and ploughed it in as green manure.
- The following cycle, farmers planted maize on these very same plots and measured the grain yield to determine the effect of green manuring against the performance and grain production of maize grown under conventional practices.

The legumes performed well in terms of bio-mass production at both Mphaila irrigation scheme and Rammbuda. The bio-mass yield of the legumes at Rammbuda was consistently

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higher for all four the legumes evaluated. At Rammbuda Sunn-hemp and Lab-lab performed the best with Sunn-hemp marginally higher. At Mphaila *Mucuna* outperformed the rest, while cow peas yielded the least green manure of the four legumes tested. The maize grain yield on the control plot was less than 1 t/ha in comparison to maize yield of 3t/ha where green manure was cultivated. The highest maize yield (just under 9t/ha) was recorded where Mucuna (green manure) plus nitrogen (N) were applied. Green manure consistently outperformed the control treatment.

The experimentation with legume green manure demonstrated to smallholder farmers the extent to which they could improve the poor soil fertility of their cropping areas and subsequently improve the grain yields from maize. This success with the incorporation of green manure in the cropping system led to other innovations. The PEA approach and focused facilitation enabled self-reliance amongst farmers that encourage them to engage in further experimentation. Farmers started to experiment with planting dates for green mealies during the winter. This farmer initiated innovation helped to sustain the smallholder farming systems at the two irrigation schemes and generally increased food security in the community. Farmers involved in planting winter green mealies experienced a substantial increase in their returns per hectare (from R20 000/ha to R45 000.ha) This farmer initiated innovation also enabled farmers to send children to school for education, built modern houses and afford them to buy necessary farm inputs.

3.3 Organisational innovation

The main organisational innovation within the soil fertility management groups was the way farmers organised and grouped themselves. A number of interest groups were established during the initial mobilisation of communities and smallholder farmers as entry point to support them through the PEA methodology and the GTZ/BASED program. In practice meetings were held for each individual interest group and mostly on different days to allow farmers to participate in all the meetings they wish to. The chairpersons and secretaries of all the interest groups collectively formed an umbrella organisation to coordinate agriculture in the village. The organisation of farmers into an umbrella organisation also helped with the grouping of farmers, especially in Mphaila irrigation scheme, to buy chicken manure collectively from poultry farmers around Dzanani and to contract a specific transporter for the transporting of chicken manure to their farms. This implies that innovation has reached a higher level of development than was assumed at onset of the initiative.

The second organisational innovation process comprised of farmer initiatives to re-organise the organisational leadership structures when the GTZ/BASED program was terminated in 2007 into one overarching association to cut down on individual interest meetings and the time spent away from the farm. Of particular interest is the fact that a collective membership was elected to accommodate all participating farmers in one meeting where crosscutting issues were discussed as well as those that are exclusive to a specific group.

4. KEY CHALLENGES ENCOUNTERED AND LESSONS LEARNED

The PEA approach, developed and implemented by the GTZ/BASED program proved that a new approach and re-training provided to extension staff was an appropriate way agricultural extension could be delivered to smallholder agriculture in South Africa. In this sense, the project-based soil fertility improvement and management innovation processes triggered farmer-initiated innovations and self-experimentation that improved livelihood situations. At

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farm level an important trigger was the desire by farmers to improve on-farm income and improve livelihoods, which they achieved through out of season production of green mealies and improvement of soil fertility.

By June 2005, 389 extension officers had been trained in the five phases of the PEA learning cycle. Of these extension officers 142 were trained in soil and water conservation, 109 trained in soil fertility management, 71 in livestock production and 67 in small scale seed production. Each officer was only trained in one technical area. About 200 farmer trainers had been trained in the same four technical areas to help with the out scaling of the innovation (Ngwenya *et al*., 2009). About 105 villages in five districts of Limpopo Province have been implementing soil fertility management; 99 doing soil and water conservation, 98 involved in small scale seed production and 95 implementing innovations in livestock production. Besides the horizontal expansion of the PEA approach within Limpopo Province, it was also initiated in 2001 in the Eastern Cape Province and in 2002 in Mpumalanga Province (Ngwenya *et al*., 2009).

Despite these tangible successes, LDA decentralised the provincial extension service in 2007 that effectively ceased the institutional support required to progress beyond the project phase towards farmer ownership, sustainability and continued farmer-initiated innovation processes. Farmers pertinently raised the fact that after the institutional support was ceased, they found it very difficult to obtain forage legume seed to continue practicing green manuring. The key challenge identified was that decisive institutional ownership and support to provide an enabling environment, is a prerequisite for farmer-initiated innovation processes to continue beyond the project phase.

Key lessons learned in terms of innovations and going to scale:

- Innovation cases can comprise complementary innovation processes with technical and organisational aspects. In this case an institutional innovation PEA was introduced to replace a linear model of extension delivery and development of farmers in Limpopo Province, but was complimented with organisational innovations where farming existing group structures were altered to form new farmer groups and umbrella organisations which served new farmer purposes, while the introduction of soil testing and experimenting with various sources of fertilisers like chicken manure and green manure were seen as the technical innovation. This illustrates the existing of an innovation bundle.
- An innovation is likely to be more effective, and uptake is likely to be greater if it fits within the local context (farming system).
- Innovation processes are normally triggered by some need or condition that farmers face - such as compromised economic conditions and poor crop yields which farmers blamed on poor soil fertility.
- Organisational structures that allow for interaction between key role players are important enabling factors for the innovation process. The following stakeholders were involved in this innovation namely: local traditional leadership; farmer umbrella organisation; livestock farmers; tractor owners; Home Based Care Groups; GTZ/PDA BASED facilitators and NTK cooperative. Where a range of stakeholders like these with different focal areas and skills sets apply, it usually allows for more effective solution if groups have clear complementary roles rather than overlapping.
- Extension staff of Limpopo Department of Agriculture received purposeful theoretical and practical training to master participatory methodologies. They were allowed to

specialise in one of five technical areas. This gave them the confidence and knowledge base to engage with smallholder farmers to solve their problems.

- One key support role that extension advisors should be able to provide is that of an "innovation broker" – a person or organisation that from a relatively impartial, party position, purposefully catalyse innovation through bringing together stakeholders and facilitating their interaction.
- This analysis illustrates where innovations are embedded within projects. Project-initiated innovations emerging from development programs are worthwhile opportunities to create appropriate enabling environments to trigger farmer-initiated innovations. This GTZ/ Provincial Department of Agriculture (PDA) BASED agreement led to smallholder innovation processes that solved problems and explore production opportunities that increased the benefits from their smallholder cropping systems. Further, self-organisation by farmers changed the social structures to reduce the number of meetings and the time away from their farms. Importantly, the innovations specifically aimed at improving smallholder livelihoods.
- Innovation processes like the soil fertility management system has had a range of tangible and intangible benefits for farmers. The tangible benefits are the improvement of soil fertility and reduced fertiliser costs, while the less obvious benefits are the changes in the way people view agriculture and the increased level of pride that they have in their work.

In conclusion, the scale at which an innovation will be taken up by other farmers within Vhembe and surrounding areas in the country depended on its potential for contributing to economic growth and improved livelihoods. Despite the fact that this innovation has the potential for replication in other regions in Africa and in the developing world, the local conditions allowing for collective action must be satisfied and taken into account. The diversity of cultures makes it impossible to come up with a "one-fits-all solution" for development.

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