1 Introduction

The Northern Province of the Republic of South Africa is located in the north east of the country, bordering onto Botswana, Zimbabwe and Mozambique. The province supports a population of 4.9 million people, most of whom are living in rural areas, and covers 10% of the national territory. The rural economy is heavily reliant on agriculture, and 85% of people in these areas are involved in farming.

Access to agricultural land is relatively limited, and most of it belongs to the predominantly white commercial farmers. They grow a variety of crops, such as avocados, mangoes, bananas, and litchis in the Northern region, while producing cotton, sorghum, wheat, and irrigated vegetables in the drier Central Region.

About 30% of the province is taken up by the former homelands, which accommodate nearly 89% of the population. With average farm sizes of 1.5 ha (White Paper on Agriculture, 1995), agricultural production in the area is predominantly carried out by smallholders at subsistence level. Most households see farming as an 'insurance' against food shortages and poverty, and only about a third of smallholders produce enough food to be self-sufficient. A large proportion of households are headed by women, and most earn their income from a variety of sources, many depending on remittances from migrant labour and pensions to satisfy their basic needs. Although livestock sales provide a good source of cash in the Central region, smallholders generally earn more from off-farm activities than from selling agricultural produce. The public sector provides much of the available formal employment (Schuh, 1999).

Agricultural policy

According to the new constitution of the Republic of South Africa, provincial governments are responsible for agricultural development (White Paper on Agriculture, 1995). The mission statement for agricultural policy in the Northern Province promises to *"…improve the quality of life of the people of the province by providing equitable access to agricultural resources and services, improvement of production, measures to manage risks, enhancement of food security and conservation and sustainable use of natural resources"*. This is an enormous and complex undertaking, particularly as there is still considerable debate about the role of agriculture in the reconstruction of the rural

economy and conservation of natural resources. Any attempts at reform must take account of the following factors:

- agriculture is mainly practiced by women in their home gardens or by pensioners cultivating one- or two- hectare fields to supplement the household food base;
- the uneven distribution of scarce resources, such as water and good agricultural land, among households in the densely populated homeland areas;
- maize is the staple food for the black population, but scarce and variable rainfall across most of the province means that there is little likelihood of producing good harvests;
- the majority of scientists dominating agricultural research and university institutions have a different cultural identity to the clients they are now supposed to serve.

When a democratically elected government came to power in 1994, it promised that it would fundamentally change state support for the agricultural sector, which had previously been heavily weighted in favour of commercial farmers. However, it soon became clear that the Department of Agriculture in the Northern Province was unable effectively to address the problems of smallholder farmers. Some kind of external support was needed, and was subsequently provided by the German Technical Co-operation (GTZ), which funded the Broadening Agricultural Services for Extension Delivery programme, known as BASED.

BASED

The aim of BASED, which started in 1998, is to help the Department provide extension services to the smallholders who constitute the majority of land users in communal areas of the former homelands, and to develop South African expertise in Participatory Extension Approaches (PEA). In order to develop these, the Department of Agriculture selected two pilot regions in the Northern Province, pinpointing three communities from each region as sites for case studies. In the Central Region this study was carried in the villages of: GaThaba, GaMogano and Spitzkop (see Figure 1). The first two villages are situated in the area run by Mankweng Transitional Local Council (TLC), while Spitzkop falls under the Haenerstburg TLC. All three villages lie within 65 kilometres of Pietersburg, the capital city of the Northern Province.

In all, there are 733 farmers in the three pilot villages. Most of them live in GaThaba (441), while 179 come from GaMogano and 133 from Spitzkop. Farmer groups in these villages fall into two categories: project groups and communal groups. Those known as project groups, were set up, organised and managed by a local extension officer. Communal groups were established independently of the extension services and are a way for farmers to acquire land from traditional leaders. Of the twenty farmer groups in the three villages, seven are project and thirteen are communal groups (see Table 1), with 243 farmers belonging to project groups and 490 to communal groups.

Figure 1. Map of the Northern Province, showing the study areas

▲ = BASED pilot areas in the Central District

1 GaThaba
2 GaMogano
3 Spitzkop

▼ = BASED pilot areas in the Northern District

4 Mbahela
5 Tshikonelo
6 Hagondo

Table 1. Farmer groups in the pilot villages

Village	*Number of farmers*	*Farmer groups*			
		Number of Project groups	*Average size and range*	*Number of communal groups*	*Average size and range*
GaThaba	441	1	52	8	48.6 (9-86)
GaMogano	179	5	41.6 (18-50)	2	10.5 (3-18)
Spitzkop	133	1	33	3	26.7 (15-44)
Total	733	7	243	13	490

Extension approach

One of the most influential approaches to government extension in South Africa has been the training and visit system, which has been used to promote large-scale mono-cropping agriculture. However, as it does not address the wide range of problems faced by smallholders, the NPDAE decided to develop an alternative approach that would provide more effective advisory services to resource-poor farmers in risk-prone areas.

In the past, agricultural extension programmes were primarily driven by extension agents. The relatively small number of farmers who were selected to take part in these programmes were told to follow certain procedures, and often discouraged from using traditional methods, such as inter-cropping or applying manure to maintain soil fertility. Although agents took soil samples from their fields for analysis, most farmers knew nothing about their purpose, or their results. In short, despite the fact that the stated aim of agricultural extension was to help farmers, they had no control over and little understanding of many of the activities in which they were involved.

The NPDAE and BASED have decided to adapt the Participatory Extension Approach (PEA) to the context of the Northern Province. This approach developed out of several projects in the southern province of Masvingo, Zimbabwe, which were supported by GTZ in collaboration with the government extension service AGRITEX. According to Hagmann et al. (1998), this approach integrates elements of participatory technology development, participatory rural appraisal and social development approaches, such as action-learning and 'Training for Transformation'. Strengthening local organisations is a key activity. Communities can only fully appropriate development activities if they are motivated and enthusiastic about them, and if there are effective community organisations capable of supporting the process and taking it forward. Only then can development activities be sustained without continuous external support (Hagmann et al., 1998).

PEA consists of several phases: mobilising members of the community, planning and implementing activities at community level, experimentation, and monitoring the process through self-evaluation and sharing experiences (see Figure 2). Farmers are now being given a central role in shaping and driving the process; being asked to identify their problems and develop and test a range of solutions to them.

BASED has developed a three-pronged strategy to adapt the PEA approach to the situation in South Africa. This involves:

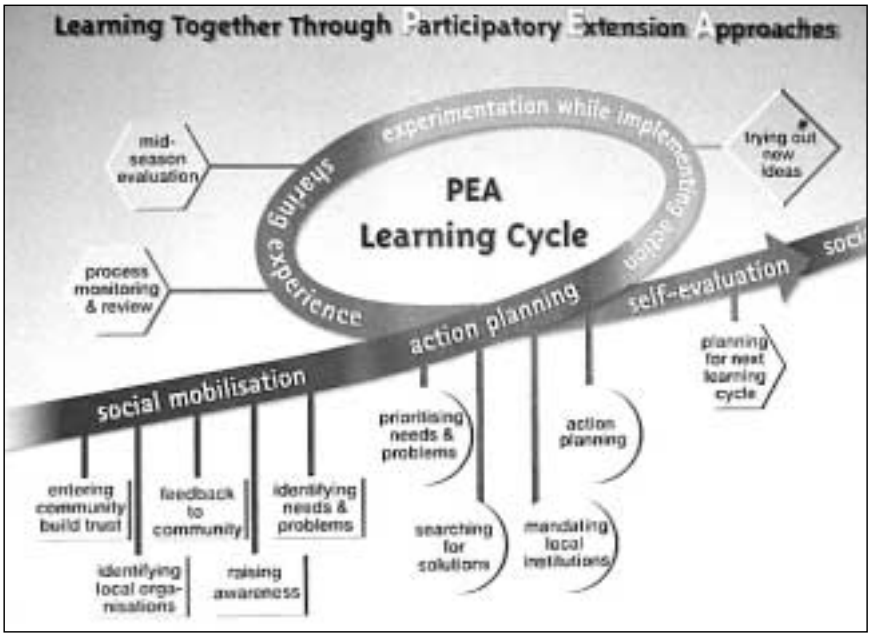
- ensuring that field staff are trained to use the approach systematically, and that they understand the dynamics of the process. This will enable them to adapt it to specific situations, rather than sticking rigidly to written guidelines;
- ensuring the process evolves in line with the livelihood systems of smallholders, rather than being developed as a top-down conceptual approach that is "applied" to farmers.
- encouraging farmers to take a leading role in experimentation and evaluation to

improve their access to and understanding of appropriate technologies.
- making known success in the field, to generate support for the approach at many levels, facilitating its institutionalisation within the agricultural service (Ficarelli, 1999);
- establishing professional links with major actors involved in the development of PEA in Zimbabwe, in order to benefit from their experience and expertise.

A training programme for forty extension staff and specialists began in two pilot regions in August 1998, with an introduction to the theoretical and practical aspects of the approach. Future PEA trainers will be selected from this group, which has so far been trained in participatory rural appraisal, participatory technology development, farmer participatory research, 'Training for Transformation', local organisational development and techniques for reviewing the process.

As the development of local organisations is seen as a key element of PEA, experimentation in the field should be paralleled by work with local farmer groups. In 1999 a considerable amount of time was spent facilitating the creation of effective organisations, capable of obtaining services, addressing problems related to agriculture and conserving natural resources. BASED carried out an institutional audit of the area, and local people subsequently set up six umbrella groups composed of representatives of different farming groups, who were mandated to address agricultural problems and lead development in the community.

Figure 2. The PEA learning cycle



2 Improving the management of soil fertility

Much of the arable land in the Northern Province of South Africa is inherently infertile and subject to unreliable rainfall. A survey conducted in the Central Region found that most of the land cultivated by smallholders is under maize, with 84% of households attempting to grow this staple food crop, despite the fact that they are unlikely to get a good harvest (Schuh, 1999).

Except for the communal fields at Spitzkop, which have sandy clay loam soil, soils in the three pilot villages are mostly sandy, ranging from sandy loam and loamy sand. Most soils lack a wide range of nutrients, particularly nitrogen and phosphorus, and there is little likelihood of increasing production unless nutrient levels improve (Skeen, 1999; Summer, 1998; see also Table 2).

Table 2. Some biophysical characteristics of pilot villages in the Central Region

Village	*Rainfall (mm/y)*	*Main soil types*	*Slope*	*Average soil depth (cm)*
GaThaba	517	Loam sand	3 – 30%	10 – 30
GaMogano	517	Loam sand & sand loam	4 – 12%	90 – 120
Spitzkop	654	Sand clay loam	1- 20%	10 – 90

Sources: du Preez (1999) and Macvicar (1991)

Improving soil fertility through the PEA process

A BASED survey revealed that 23% of farmers in the Central Region felt that they needed advice on soil fertility management. In the Northern Region, only 5.3% of those questioned expressed an interest in guidance on this aspect of farming, although 28% of them wanted general information on crop production (Schuh, 1999). During a needs assessment exercise, farmers from GaMogano and Spitzkop in the Central Region identified declining soil fertility as their most serious problem. Although it was not ranked as a key problem in GaThaba, levels of concern about the high cost of mineral fertilisers and low yields achieved by women in the project group indicated that soil fertility could also be a useful entry point in this village. In the Northern Region,

declining soil fertility was only raised as an issue some six months after the first village level needs assessment, once the most urgent problems identified during the exercise had been addressed.

BASED then decided to start a case study on managing soil fertility within the PEA process in the Central Region. Experience in Zimbabwe has shown that options are most effectively addressed through a series of phased activities with farmers. These include:

- identifying and analysing their perceptions of soil fertility;
- assessing levels of fertility and analysing the nutrient content of soils;
- sharing and discussing the results of their findings;
- strengthening links with suppliers of inputs;
- initiating a process of experimentation with improved technologies, evaluating the results and planning tests for the next season.

Perceptions of soil fertility held by farmers

The BASED project team felt that it would be useful to identify and assess farmers' perceptions of soil fertility in the area before embarking on any physical analysis of the soils. When members of various farmer groups attended a village meeting to discuss the issue, facilitators began by comparing what they were about to do with a medical examination, asking:

- What steps does a doctor take when a patient is sick?
- What would happen if the doctor prescribed medicine for you without examining you?
- What would happen if a doctor gave you the wrong medicine?
- Do patients have to pay for examinations and medication?
- How is this related to soils in your village?
- What would happen to the soil if a farmer put lime on it when it was not needed?
- If soils have to be tested, who should pay for the analysis?
- Which farmer groups would like their soils to be sampled?

After discussing what they knew about their soils and how they managed soil fertility, participants analysed the causes of declining fertility, the practices previously used to resolve the problem and how it might be addressed in the future. The results of the problem analysis are summarised in Table 3 below.

Because the constitution of the project groups obliged all members to apply fertilisers to the project fields on a regular basis, it was no surprise to discover that declining soil fertility is less of a problem in these fields than in the communal fields. In the past, extension agents actively discouraged farmers from inter-cropping or using manure, advising them to apply mineral fertilisers or lime instead. Farmers were rarely told how or why they would be beneficial, and the results were sometimes very disappointing: *"We once applied lime to our soils with the hope that it would reduce the infestation of*

Table 3. Perceptions of declining soil fertility in the three pilot villages

Village	*Description of the problem*
GaThaba	• Poor crop yields • Yields will only improve if fertilisers are used • Soils are mostly sandy and need more fertiliser
GaMogano	• Declining yields • Crops become stunted after weeding • Maize leaves turn yellow, even after fertilisers have been applied • Maize grown on infertile soils is badly infested by striga
Spitzkop	• Manure gives better maize yields than mineral fertilisers • Maize crops produce small cobs when they are only knee-high • Erosion is a major cause of infertility • Maize leaves are pale and yellowish

termites on our crops, but instead their population increased. This is what we have been told by extension and that is what we know about lime" (Phegelelo project group, June 1999).

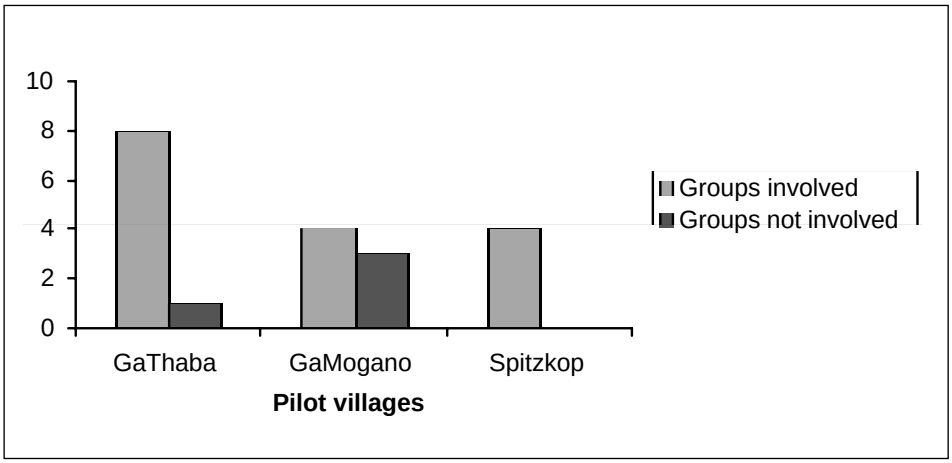
Planning soil sampling with farmers

Soil testing can help farmers to fine-tune the type and amount of inputs they use (Summer, 1998), but while this type of service is available for larger, commercial operations, it needs modification to make it widely accessible and useful to smallholder farmers. During the course of our meetings it emerged that although extension officers used to take soil samples from these fields, farmers working in the project plots were often unaware that their soils had been tested, as they were neither involved in the sampling nor told of the results. Having been largely ignored by extension agents in the past, most of the farmers from communal groups were unaware of the possibilities offered by soil analysis. Once they found out about it, they expressed an interest in exploring how it could help improve the fertility of their fields, and it was agreed that soil samples would be taken from communal fields that had not been tested before. This would clarify the nutritional status of the soils and enable farmers to select the most effective options for improving soil fertility.

It was agreed that samples would only be taken from the fields of interested groups, and that while BASED would organise the sampling and help put farmers in touch with the laboratories, the farmers would pay for the analysis themselves. After the village meeting with the BASED soil fertility team, representatives of farmer groups reported back to their colleagues, asked what they thought about the proposal to carry out soil analysis, and then attended further meetings with the project team to discuss:

- which groups had collected money to pay for analysis
- when the soil samples should be taken

Figure 2. Involvement of farmer groups in testing their soil



- which farmer representatives would be part of the soil sampling team
- when they should meet to discuss the results of the analysis

In GaThaba and Spitzkop, the response to proposals to go forward with soil analysis was generally very positive, and the main reason for not getting it done was inability to pay for it. Some farmers said that they were not interested in having samples taken because their fields were new and still fertile, while others held back because their fields had just been tested by the fertiliser company – although these individuals were never able to obtain the results of the analysis. In the end, project groups contributed money from group funds, while most of the communal groups had to raise money by collecting from individuals. However, some farmers were unhappy about having to pay for a service that fertiliser companies had previously provided free of charge, and almost half of the groups from GaMogano did not participate (see Figure 2). Once it had been agreed which fields were to be tested, soil samples were collected and sent to the Institute for Soil Climate and Water (ISCW), for analysis of the physical and standard chemical properties. A negotiated rate of R 48 ($8) was charged per sample, which was a 60% discount for resource-poor farmers.

Discussing the results of soil analysis

When the results came through, the team used guidelines from Borman et al. (1989) and Landon (1991) to rate the levels of essential elements. The team developed several tools to present the results of the soil analysis and the role of organic matter in soils. They made colour posters illustrating the symptoms of nutrient deficiency using local language terms. In the meeting they used a lever scale to illustrate the water holding

capacity of soil and manure, and a magnet and pins to demonstrate the importance of manure in increasing the nutrient holding capacity of soils (see photo).

These tools proved a highly effective means of presenting analytical results in a simple format that enabled farmers to understand the nutritional status of their soils. Participants could then discuss the perceived and actual levels of nutrients in their soils, and consider how they might be improved. In conclusion, feedback of the results of soil analysis was a learning process for the soil fertility team. Presenting scientific results or information in a manner that farmers would understand was a challenge to the members of soil fertility management team.

The results of the analysis reflect, in part, the different rates at which fertilisers had been applied to the project and communal fields. Table 4 shows that except for Spitzkop, the pH of soils in communal fields is generally higher than that in the project fields. Phosphorus is generally low in the communal fields, but very high in project fields, particularly at GaThaba. Calcium and magnesium were slightly below the minimum required levels in both project and communal fields. Except for GaThaba, potassium levels were generally high in the project fields, and lower in the communal fields at GaMogano.

Table 4. Average values of soil parameters in samples from project and communal fields in pilot villages of the Central region

Soil parameter	*GaThaba*		*GaMogano*		*Spitzkop*	
	PF (N=1)	*CF (N=7)*	*PF (N=2)*	*CF (N=2)*	*PF (N=1)*	*CF* (N=3)
pH (water)	5.6	6.3	5.8	7.2	6.0	5.9
P (Bray1) mg/kg	150	15.1	28.1	18.4	6.0	0.9
Ca ($cmol_c$/kg)	2.4	1.8	1.0	3.8	1.3	2.2
Mg ($cmol_c$/kg)	0.98	0.80	0.54	1.54	0.67	1.02
K ($cmol_c$/kg)	0.39	0.26	0.35	0.45	0.18	0.27
Na ($cmol_c$/kg)	0.10	0.05	0.05	0.06	0.05	0.06
Titratable acidity ($cmol_c$/kg)	0	0	0.08	0	0	0

Key: PF = project field; CF = communal Field

The soil fertility team used the information presented in Table 4 to suggest various options for experimentation. These included:

- Substituting fertilisers with manure, which contains nutrients and improves soil structure and infiltration capacity. As most of the soils in the pilot villages are sandy, manure would also increase their buffering capacity[1];
- Applying any mixed fertiliser containing N, P, and K or super-phosphate to communal fields;
- Using dolomitic lime to supplement calcium and magnesium levels. (It should be noted that in this case it was proposed for nutritional reasons, and not to counteract soil acidity);
- For farmers who wanted to apply top-dressing, Lime Ammonium Nitrate (LAN) was recommended as a better option than other nitrogen fertilisers.

Misunderstanding farmers' needs

The first feedback meeting to discuss the results of the soil analysis was held in the village of GaMogano, and erupted into an argument over the proposed feedback programme. Farmers there had already expressed their unhappiness at having to pay for the soil analysis, and attended the meeting in large numbers.

The meeting opened with the usual prayer, welcome and introductions. We outlined the objectives of the meeting, and the facilitator then asked several farmers to redefine the

[1] According to Borman et al. (1989), it is necessary to apply up to 15 tons of kraal manure and 5 tons of chicken manure per hectare. Studies of crop production by small-scale farmers in the Eastern Cape found that up to 20 tons of kraal manure are required each cropping season to achieve optimum yields (Yoganathan et al., 1998).

problem of declining soil fertility. This was done to bring newcomers up to date, and the farmers seemed happy to oblige. Next, the team had planned an exercise designed to enable farmers to put the results from the soil analysis into a broader context. The team felt that it was important to carry out this exercise for two reasons: to raise awareness of declining soil fertility, and to enable farmers to understand how the causes of declining soil fertility lead to the results shown in the soil analysis.

However, the mood suddenly changed when farmers were asked to form small groups to look into the root causes and effects of declining soil fertility. To everyone's amazement, they refused to do so, arguing that all they had done since BASED started working with them was form groups and give out information, and they were fed up with it. The farmers demanded to see the results of the soil analysis immediately. Although the facilitators tried to explain the purpose of the exercise and how it was linked to feedback on the results of their soil samples, the farmers were adamant that they would only stay at the meeting if they were given the results of soil samples first. Some of the members of the umbrella organisation tried to persuade them to keep to the planned programme, but when the farmers refused to back down, the facilitators had to fall in with their wishes.

Several points emerged from this incident:

- The programme should have been drawn up in consultation with participating farmers, not just with the village leadership;
- The soil fertility team underestimated the farmers' eagerness to hear the results of the analysis. This was the first time that many of them had been able to find out about the nutritional status of their soils, and it should not be forgotten that their hard-earned money had paid for the service;
- Knowing from experience that meetings take a long time, the farmers may have thought that the proposed exercise would not leave enough time to discuss the results of soil analysis in any detail.

Organising supplies of inputs

The presentation and discussion of the results of the soil analysis enabled farmers to get a better understanding of the nutritional status of their soils, and to consider the options for improving soil quality. The next question was how to get hold of the necessary inputs. Farmers knew where they could buy some mineral fertilisers, but had little idea about others, such as dolomite, which most of them had never used before. Some of the project farmers had used calcitic lime in the past, but as their extension agent had always organised everything, they did not know how to go about it. Having decided to start using various new types of inputs to fertilise their fields, farmers needed to consider several points:

- Where could they buy the different inputs, and was it possible to meet and get quotations from various suppliers?

- What is the most efficient way of buying fertilisers?
- How could umbrella organisations help them?
- Who should pay the delivery costs?

Dolomite

Some of the farmers decided to use dolomite to increase levels of magnesium and calcium in their soil, and the umbrella organisations selected one representative from each pilot village to go and meet suppliers. Having discussed costs and conditions for transporting the product back to their villages, they returned with the news that the company would only deliver orders over 20 tons, and would charge R7 (1$) per 50 kg for supply and delivery. A certain amount of organisation was required to make a purchase of this size, and in the end seventy-four farmers from the three villages were able to meet the minimum requirements by jointly ordering 649 bags of 50 kg. Everyone was pleased with the outcome, and felt that the newly established umbrella organisations had been helpful and effective.

Chicken manure

Another group decided to use chicken manure as a soil amendment. When farmers from GaThaba went to visit the Lunds Maraba chicken farms, they found that the manure was being dumped in fields, and were told that they could take as much as they wanted. The news that free chicken manure was available quickly spread through the village, and a collection was organised to hire a local truck to transport it: *"I was just about to buy manure for my field from a neighbouring village at R350. On top of that, I would have had to pay R400 for transport. Now that we are organised and can hire a big truck together, I can take home six bags of 80kg of chicken manure at the cost of only R34. Being together saves money"* (farmer from GaThaba village). A total of sixty farmers from GaThaba banded together to collect almost 3000kg of manure in this way, while others from the village used their own transport. Farmers from neighbouring communities quickly followed suit when they heard what was going on.

Mineral fertilisers

South Africa is one of the few countries on the continent with a fertiliser industry. Fertiliser depots have recently been set up to facilitate deliveries to the small-scale sector. After receiving the results of the soil analysis, most of the farmers decided that they needed to use more mineral fertilisers. All the suppliers operating around the three pilot villages were invited to a meeting to discuss prices, delivery and the different packages on offer. In the event, only one representative turned up to the meeting. Farmers decided that they would pool their orders so they could buy in bulk. It was agreed that umbrella organisations in the villages would be responsible for organising orders, collecting money from the individuals who had ordered goods and paying the agent on delivery, and 494 farmers from 20 different groups used this system to buy a total of 887 bags of fertiliser.

Although farmers were generally pleased with the fact that buying in bulk gave them better access to cheaper mineral fertilisers, they highlighted a number of weaknesses in the system:

- Umbrella organisations seemed less efficient at buying mineral fertilisers than they were at obtaining dolomite (GaMogano and Spitzkop) or chicken manure (Gathaba). Individual farmer groups seem to have taken over the collection of money;
- Farmers from communal groups tended to rely on project groups to get access to fertilisers, as they were better organised;
- The supplier did not always deliver fertilisers at the agreed time and date and, although farmers collected money to cover the quoted cost, they often found that prices had risen by the time goods were delivered, and they were then charged at the new rate;
- The fact that so many more farmers bought mineral fertiliser than manure indicates that it takes time to change old habits, although we found that some farmers were starting to use a combination of mineral fertilisers and chicken, cattle or goat manure.

Experimenting with new options

A meeting was organised with farmers to consider possible experimental designs and the indicators that would be used to assess their performance. Although the team agreed that all farmers experiment in the course of their work, they pointed out that it was not possible to work with everyone, and they would therefore need to select volunteers to try out the new technologies. Participants then discussed:

- which trial options could be tested over the summer and what they wanted to learn from them;
- which criteria would be used for evaluation and when the trials would be assessed;
- which results should be discussed, and when.

Although many farmers were initially enthusiastic about experimenting with new technologies, relatively few got beyond the planning stage and actually carried out tests in their fields, so it is not always easy to get a set of farmers to follow the process through from start to finish.

It was also hard to convince project farmers to become involved, as they were not permitted to inter-crop or use manure on the project fields. In GaThaba, farmers expected to be fined if they planted anything other than maize in the project fields, and they reported that their extension officers had told them that "one crop would eat another" if they tried inter-cropping. However, these farmers did inter-crop their communal fields and back yards, where extension officers had no say over what was planted. In fact, once most of the experiments had been laid out, some of the project group decided to risk volunteering to join the trials, and most of the experiments were eventually set up in project fields (see Table 5).

The trials went ahead with 32 women and 4 men, generally using their least productive plot as trial sites. There were some minor setbacks, such as trials being set up on termite hills hidden by recent ploughing, or the loss of pegs when the soil was prepared.

Table 5. Frequency of experiments tested in the three pilot villages

Type of	*GaThaba*		*GaMogano*		*Spitzkop*		*Total*
experiment	*PF*	*CF*	*PF*	*CF*	*PF*	*CF*	
Mineral fertiliser*	-	5	4	-	4	-	13
Dolomite	2	1	-	1	3	1	8
Dolomite + Mineral fertiliser	1	4	3	1	6	1	16
Chicken manure	5	1	-	-	-	-	6
Chicken manure + dolomite	7	2	-	-	-	-	9
Kraal manure	4	2	-	-	-	-	6
Kraal manure + dolomite	4	1	-	-	-	-	5
Goat manure + Mineral fertiliser	-	-	1	-	-	-	1
Total	23	16	8	2	13	2	64

Key: PF= Project Field; CF= Communal Field; Fertiliser formula is N:P:K = 2:3:2

Soil samples were taken from the fields of farmers who volunteered to take part in the controlled experiments, first when the experiments were set up and then at harvest time. Random samples of cattle and goat manure were also taken from kraals, to determine the general nutritional status of manure in the pilot villages, and to develop a database for future experiments on different methods of conserving nutrients in manure. Analysis was also carried out on samples of fresh and decomposed chicken manure.

The general nutritional value of the soils sampled when the experiments were laid out was fairly similar to the results of the previous analysis done at the start of the process (see Table 4). The pH had risen slightly as a result of applying dolomitic liming material, but levels of phosphorus were generally low.

The N, P, and K content of the cattle and goat manure collected from pilot villages was rated on a scale developed by Nzuma and Murirwa (2000). This showed that while the nitrogen content was generally similar, potassium levels were higher in goat manure than in cattle manure, while the phosphorous content was generally low for both types, with the exception of the goat manure from Spitzkop. Nzuma and Murirwa (2000) attribute these low nutrient levels to the conditions under which manure is stored and

Table 6. Average application rates of different inputs during the 1999/2000 season

	Application rates(tons/ha)					
Village	*Mineral Fertiliser*	*Top dressing*	*Dolomite*	*Goat manure*	*Cattle manure*	*Chicken manure*
GaThaba	0.2	0.1	2.1	7.2	5.9	11.6*
GaMogano	0.4	0.2	1.6	2.4	-	-
Spitzkop	0.2	0.9	2.3	-	2.0	-

Fertiliser was 2:3:2, top dressing was Lime Ammonium Nitrate; *The amount of chicken manure was estimated

Table 7. Effects of different amendments on the chemical properties of soils in project and communal fields in pilot villages of the Central Region

Type of amendment	*Type of field*	*Number of samples*	*Chemical property*						
			pH	*P*	*%C*	*CEC*	*Ca*	*Mg*	*K*
			(water)	*(Byar 1)*		*(cmolc/kg)*			
Mineral Fertiliser	PF	7	6.8	23.3	0.6	5.3	1.5	0.6	0.3
	CF	5	6.7	11.6	0.4	7.9	2.8	1.2	0.4
Dolomite	PF	6	6.5	7.0	0.6	4.2	1.0	0.5	0.3
	CF	5	6.9	12.1	0.9	7.4	3.0	1.5	0.3
Fertiliser + dolomite	PF	9	6.3	16.7	0.7	3.6	1.1	0.6	0.3
	CF	6	7.2	12.8	0.6	7.9	3.4	1.7	0.3
Chicken manure	PF	4	6.1	9.3	0.7	5.0	1.9	0.5	0.4
	CF	1	6.1	13.1	0.2	3.7	0.8	0.4	0.2
Chicken manure + dolomite	PF	6	6.9	8.0	0.8	5.2	2.4	0.7	0.4
	CF	2	7.3	17.2	0.3	4.2	1.8	0.7	0.4
Cattle manure	PF	2	5.9	6.8	0.6	4.2	1.2	0.5	4.2
	CF	2	6.7	9.9	0.4	6.0	2.4	1.4	1.3
Cattle manure + dolomite	PF	3	6.2	1.8	0.7	3.6	1.5	0.6	0.3
	CF	2	6.6	18.6	1.1	8.5	3.2	1.8	0.3
Goat manure + fertiliser	PF	1	6.4	7.2	0.4	3.7	1.3	0.7	0.6
No input added	CF	3	6.3	6.1	0.6	7.7	1.8	0.9	0.4

Key: PF= Project Field; CF= Communal Field; Fertiliser formula is N:P:K = 2:3:2

handled, its moisture content and exposure to the environment. However, its performance can be improved by combining it with mineral fertilisers (Omiti, 1998).

Having seen that adding amended inputs increased the pH values and calcium content of soils in the communal fields (see Table 7), farmers were warned about the dangers of over-liming, especially with dolomite, and encouraged to use more manure to increase the organic matter and CEC content of their soils.

Assessing the new technologies

The SFM team wanted to monitor the following indicators in a set of more controlled experiments to assess the new technologies:

- length of time taken for crops to emerge, tassel, silk and ripen;
- height;
- number of cobs;
- signs of nutrient deficiency;
- infestation by pests;
- yield (grain yield and mass of stover).

Farmers suggested observing the speed at which crops responded to the different options, and greenness or signs of nutrient deficiency.

Test and non-test farmers were invited to attend meetings held to assess the experimental technologies, evaluate progress since the previous season and get feedback from the farmers involved in experimentation. The information was then used to plan the options for the next season and develop fact sheets on technologies that had performed well and were suitable for more widespread adoption.

Rating the new technologies

To rank the new technologies, each group of farmers in the community was asked to assess the options they had tested the previous season. Once they had chosen a facilitator to help them reach an overall consensus, the groups went on to identify criteria that could be used to assess the different options. A large sheet of laminated paper was used to draw up a matrix, with all the technology options in the vertical column and the criteria for assessing set out horizontally (see picture below). Farmers could then rate each option, using one cross to indicate a poor performance, two crosses for an average score, and three crosses for a good rating. By adding up all the scores at the end of the exercise, they could give each option its final ranking.

Depending on the number of criteria used to judge them, a range of scores was developed to rank the performance of each option, so that the lowest score for an option assessed according to five criteria would be 5, and the maximum 15. The different options were then classified into the following categories:

- Poor performers: not recommended for dissemination;
- Options with specific constraints: need further experimentation;
- Good performers, providing that they were used under certain conditions;
- Good performers, ready for dissemination with an accompanying fact sheet drawn up by farmers.

Each group selected a spokesperson to present and explain their assessment of the technology options at a plenary meeting, and the facilitator concluded the exercise by helping participants identify and discuss the differences and similarities across the different farming groups.

The new technologies were judged according to a number of criteria, such as the cost of inputs, yield obtained, accessibility, how easy the technology was to use and how much labour it required. All the farmers reported that they had more success with manure than with mineral fertilisers, which performed poorly when applied on their own, but were much more effective when used in combination with manure (see Table 8).

A number of farmers carried out their own, independent experiments, which were also included in the evaluation. Their example enabled the soil fertility team to emphasise the fact that all farmers experiment, and the importance of sharing their experience with colleagues. It transpired that some had obtained very promising results with malt, sawdust and ash, but that most farmers were unaware of their potential as fertilisers because there was no regular forum to discuss such matters (see Table 9).

Table 8. Rating of technologies implemented by farmers in conjunction with the soil fertility team

GaThaba		*GaMogano*		*Spitzkop*	
Technology	*Average score*	*Technology*	*Average score*	*Technology*	*Average score*
Dolomite + fertiliser	14	Goat manure + fertiliser	15	Cattle manure + dolomite	12
Chicken manure + fertiliser	14	Dolomite + fertiliser	13	Dolomite	11
Cattle manure + fertiliser	14	Fertiliser	12	Fertiliser	10
Cattle manure	14	Dolomite	11	Dolomite + fertiliser	10
Chicken manure	13				
Dolomite	13				
Chicken manure + dolomite	12				
Chicken manure + dolomite	12				
Mineral fertiliser	11				

Table 9. Rating of soil fertility technologies independently initiated and implemented by farmers

GaThaba		*GaMogano*		*Spitzkop*	
Technology	*Average score*	*Technology*	*Average score*	*Technology*	*Average score*
Goat manure	12	Goat manure	15	Ash	15
Goat manure + dolomite	10	Chicken manure	15	Saw dust	14
		Malt+ dolomite + fertiliser	13	Goat manure	13
		Cattle manure	6	Malt	11

Planning for the next season

We have just held several meetings with farmers to develop plans for the coming planting season, based on experiments carried out in the three pilot villages during the 1999/2000 season. Knowing the analytical results of soil samples taken at different stages of the process has helped farmers better to understand and reassess the fertility status of their soils, and to make informed choices about the next round of experiments. There is now more interest in some of the options that few wanted to try the previous season, such as inter-cropping and using compost and various types of manure. Some farmers are going to try boosting the current low levels of phosphorus in the communal fields with super-phosphate, others will use sawdust, which is readily available from the wood factory in Spitzkop, and several farmers from GaMogano and Spitzkop have expressed an interest in using malt residues. The farmers have decided to organise a competition for the best innovation, which will be open to all farmers carrying out experiments.

Each farmer group is going to nominate two farmers to carry out controlled experiments over the next season. The soil fertility team will be able to monitor certain criteria with them, and will also do some quantitative assessment of the chemical properties of their soils.

Farmers were asked to draw up fact sheets on the most promising technologies, such as chicken manure (GaMogano), kraal manure + dolomite (GaThaba) and sawdust (Spitzkop), taking account of how much was already known about using them as an input, how easily accessible they are to most of the community, and possible side effects, such as fresh sawdust causing nitrogen deficiency.

Spreading the word about PEA

One of the main aims of BASED is for farmers to share their experience of PEA with as many of their colleagues as possible. In addition to the more usual field days, all the farmers in the area have been invited to mid-season evaluations held at experimental plots. These occasions have proved to be a popular and effective way of engaging new farmers in the process.

Family and friends can also be used to spread the word beyond village boundaries. For example, after a farmer from GaThaba told her sister in nearby Mmakata that chicken manure was easily available from a particular outlet, a group of farmers from Mmakata organised transport so that they could get it from the same source. As Veldhuizen et al. (1997) found, networks of friends and relatives are particularly efficient conduits for disseminating new technologies.

When some of the villages around the pilot sites in the Central Region expressed an interest in joining the programme, the soil fertility team decided to set up a pilot project in one of these villages: Rampheri. There are 702 farmers and 11 farmer groups in this village, which has already sent representatives to a number of events organised by farmers in nearby GaMogano, such as discussions about strengthening the village umbrella organisation, meetings with fertiliser suppliers and the mid-season evaluation of experiments carried out by farmers. The village leaders are both well respected and fully behind the process. PEA for soil fertility management has already begun in Rampheri, with awareness raising sessions on soil fertility, soil sampling and discussions about the results of sample analysis.

As leadership in this village is strong and organised, meetings with farmers are always well attended, and it is hoped that this bodes well for the next stage of the project. The aim is to build on existing contacts between the two villages, although a number of issues will need to be addressed to ensure that the process progresses smoothly. Some of the farmers from Rampheri noted that *"we have heard and seen a lot of things achieved by farmers through self-organization at GaMogano. But the problem is that when the leaders from this village organise meetings, they only invite farmers from our village who are working in the project fields, and we in the communal fields are not being considered. We also would like to copy some of the things that farmers at GaMogano have succeeded with. But without first testing our soils and finding out what is good for us, it is dangerous to imitate them, because what worked for them may not work for us".*

Towards institutionalisation of PAE

Parallel to its work with the BASED pilot programme, NPDAE is also involved in other initiatives, many of which embody more traditional attitudes to service delivery to rural communities, and use very different approaches to that of the BASED programme. Over the last two years the BASED case studies have generated a good deal of interest about different ways of working with smallholder farmers, and have also made people uncomfortably aware of the shortcomings of previous extension approaches.

This prompted the Chief Directorate of Regional Affairs to start an internal evaluation of service delivery by all programmes, including BASED, aimed at harmonising approaches within NPDAE and enabling regional directors to become more effective at tailoring approaches to different client groups. To launch the evaluation, a workshop has been organised to identify common departmental values and criteria against which each programme can be assessed. The next step will be to hold a number of joint workshops with community leaders, local farmer organisations, executive programme staff and regional managers, to assess what difference each programme has actually made to its beneficiaries. The process of self-assessment is only just beginning, but it may constitute a significant step towards institutionalising PEA values and practices within NPDAE. By

identifying the training needs of the extension service as a whole, and using the training process spearheaded by BASED in the two pilot regions, it should be possible to disseminate and implement the approach in other regions.

BASED has also been instrumental in building relationships with a number of research programmes, both within and outside NPDAE. One such organisation is the Agricultural Research Council (ARC), a huge research institution that has previously focused on the needs of the commercial sector. Making its research more relevant to smallholders will be an enormously challenging process for ARC, but despite some initial difficulties, the institute has successfully co-operated with NPDAE on a number of initiatives. With BASED acting as facilitator, professional links have now been established with different divisions of ARC, ranging from biological management of pest control to the development and improvement of animal-drawn implements, livestock, maize varieties, and soil fertility management. This experience has also made NPDAE management aware of the need to improve the mechanisms for co-ordinating initiatives between NPDAE and ARC at provincial level. A series of meetings may be seen as a positive indication that the new management of ARC is serious about meeting the needs of smallholders, and responding to the changing needs of the Provincial Departments of Agriculture.

3 Conclusions

The current fertility status of soils in the former homelands of South Africa partly reflects approaches and practices previously promoted by the extension services. Targeted programmes largely ignored farmers working in communal fields, while actively discouraging those in the project fields from experimenting with new techniques. In the name of 'modern' agriculture, these farmers were restricted to monoculture, obliged to use large quantities of mineral fertilisers and fined if they did not follow the regulations laid down by the extension services. This has not only resulted in high levels of residual phosphorus and potassium in the project fields, but also caused initial resistance to innovation in soil fertility management among farmers that had previously been on the receiving end of extension.

New approaches to extension are based on inclusion and willing participation, rather than exclusion and coercion. Instead of focusing on a few 'project' farmers, the aim is to encourage as many farmers as possible to experiment with a range of alternative methods of improving soil fertility. While farmers working the project fields used to look down on their colleagues in the communal areas, attitudes have changed considerably as the willingness of communal farmers to experiment has made them a source of inspiration and encouragement to others.

The experiments on soil fertility management carried out by farmers in the 1999/2000 season have been used to mobilise the rest of their communities to try out similar techniques and introduce sustainable alternatives to mineral fertilisers. Future experiments should focus on using organic inputs such as manure and compost, which are cheaper than mineral fertilisers, and would also improve the physical structure of the predominantly sandy soils in the region. However, they will only be really effective if nutrient loss during storage and handling of manure is minimised, so farmers need to experiment in this area as well.

Learning through experimentation is not limited to soil fertility management. By the end of the 1999/2000 season, BASED was also running a number of soil and water conservation activities and verification trials for different seed varieties and potatoes in the Central Region, and a successful programme of poultry vaccination, trials with sweet potatoes and processing sweet sorghum into juice and syrup in the Northern Region.

Farmers have seen that experimenting with different methods of improving soil fertility and sharing the results with each other is a valuable way of collectively addressing specific agricultural problems. Action-learning not only raises awareness about SFM, but also motivates farming communities to address other issues, such as conservation techniques, promoting farmer organisations and strengthening local institutions and leadership.

The experiences of the NPDAE and BASED have provided many useful lessons about extension in general and soil fertility management in particular. On an institutional level, this case study gives a clear indication of the role that NPDAE extension services could play in the future, shifting the focus from producing technical packages and supplying inputs to providing services and facilitating community learning and experimentation. This would also reduce the widespread dependency on government services, a politically sensitive issue that affects the provision of services to disadvantaged rural communities. More stringent regulation of private service providers, such as fertiliser and seed companies, is also necessary in order to safeguard groups of smallholders who are less able to articulate their needs and exert their rights than large-scale commercial farmers.

Finally, it is essential that researchers acquire the skills to enable them to share scientific concepts with farmers, who should be regarded as equal partners in development initiatives. Establishing dialogue, understanding and mutual respect is a pre-requisite for widespread and genuine commitment to innovative processes. Research and extension staff working with smallholders also need training in facilitation techniques and different aspects of local organisational development. Research stations and satellite centres under the management of NPDAE should become centres where farmers can see and find out about new techniques, and for relevant adaptive research into possible solutions to problems identified by farmers.

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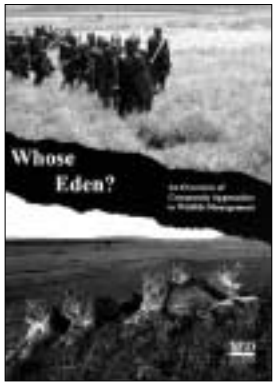

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