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Development of emerging farmer crop–livestock systems in northern South Africa

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1 Acknowledgments

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2 Executive summary

In the Republic of South Africa, there have traditionally existed dual agricultural sectors: commercial and subsistence based farming systems whose evolution is based on the land and social policies of pre-democracy governments. The post apartheid land reform policies of land restitution and redistribution have created opportunities for the previously disadvantaged population to own and farm land. These new farmers, together with farmers from the subsistence sector who are attempting to commercialise, now make up a third middle sector termed the 'emerging farmer' sector. Whilst much hope is vested in the emerging farm sector, there are significant barriers to, and few examples so far of, its success. This project, initiated in 2005, aimed to improve the sustainability of emerging farmers who operate in crop or livestock farming systems in the Limpopo Province and to support researchers and extension staff to develop systems based participative research and extension programs to assist land reform farmers make the transition to commercial farming.

Work that targeted land reform farmers in the livestock sector was conducted in 4 areas with divergent climate and resource endowments - Steilloop/Rebone (Waterberg), Maboi (Capricorn), Mannamead (Capricorn) and Nwanedi (Vhmebe). The on-farm field activities included: establishing veld monitoring sites; erecting exclosures to identify relictual site potential and to test the feasibility of spelling, shrub control and other reclamation strategies to reclaim lost productivity of the pasture resources. The limited knowledge base farmers and extension officers had about managing commercial farms was quickly identified as a key constraint, so capacity building became the focus. Over 70 farmers and 20 extension staff participated in several multi-day training courses and follow-up workshops. The development and distribution of appropriate extension material (covering veld, animal and financial management), training course material and a farm model which could be used to compare farm system improvement strategies, became part of these capacity building efforts. These efforts have resulted in at least 20 land reform farmers implementing changes such as reduced stocking rates, rotational grazing and better herd management and marketing. This is evidence that on-going efforts to build capacity in local extension staff and farmers and introduce practical and low risk technologies can be successful.

Within the cropping sector (rainfed cereal based systems), no emerging farmers were identified as obtaining farms through the land reform programs. The project therefore targeted existing smallholder farmers in the former homelands who aspired to selling produce. An extensive 4 year program of applied field research based around the themes of improving soil fertility, agronomic management and the introduction of grain legume-based cash cropping was established in 4 large farming communities: (i) farmer associations at Perkesbult/Bloodriver in Capricorn district; (ii) smallholders in the village of Dwzerani, Vhembe district; (iii) in the Mafarana and Gabaza villages in Mopani district; and (iv) in the Kulani and Sismukani villages of Bohlabela district (Mpumalanga Province). The activities included demonstrations, researcher/student trials, farmer experiments, farmer discussion workshops, field days and farm walks. A key outcome of this work was to demonstrate that more that 50 resource poor farmers were able to transform low-productivity maize-based farming systems into more-profitable enterprises by incorporating grain legume cash crops into rotations with maize and adopting simple agronomic practices. Many of these farmers can now package, store and sell high-value legume products when, just three years earlier they were barely at subsistence levels of food production. Another notable success of the crop-based work included the development of guarbean as a potential industrial cash crop (seed multiplication, variety evaluations, harvesting, processing and market development), identification, testing and the multiplication of 5 short season multi-purpose lablab lines for use as forage in rotation with maize and promotion of well adapted and high value cowpea lines. In association with this work, 2 female students completed MSc level studies, 5 others obtained honours

level dissertations and in March 2010, two MSC students were nearing completion of their theses.

The political imperative to implement land reform in South Africa is intensifying. Sensible policies, secure land tenure and on-going support of new farmers will go a long way to securing the agricultural production future of Limpopo Province. Within the government agricultural services there does still exist a limited capacity to support emerging farmers with appropriate advice, input support or infrastructure investment. This project has demonstrated the importance of investing in capacity building (farmers, extension staff and researchers), targeting appropriate communities for change and identifying local champions (farmers and extension officers) which can result in positive changes in rural communities. In the smallholder-homeland communities, the limitations of 'permission to occupy' and farm size (1-2 ha) will generally limit farming enterprises gaining economies of scale. Transformational changes such as mechanisation and conservation agricultural practices that are necessary to improve sustainability will therefore require some public-private initiatives and state support.

3 Background

Limpopo Province, one of the nine provinces of the Republic of South Africa, shares international borders across the Limpopo River with Botswana, Zimbabwe, and Mozambique. The Province is divided into 5 districts, Capricorn, Mopani, Sekhukhune, Vhembe, and Waterberg, and covers an area of 12.5 million (M) hectares (ha), constituting 10% of South Africa's total land area of 122 M ha (Statistics South Africa 2006). Of the total land area, 6.3 M ha (50%) is used for grazing; 1.7 M ha for nature conservation and 0.9 M ha is arable farmland. The remaining area supports forestry, urban and rural communities, mining and other non-agricultural activities.

Limpopo is generally situated in a dry savannah sub-region, characterised by open grasslands with scattered trees and shrubs. There are 15 veld types represented in the province covering the 3 biomes of bushveld, grassland and forest (Adcocks 1988). The climate and vegetation, which are modified by mountain ranges and elevation, vary widely from semi-arid and arid rangelands through to sub-humid forests. Rainfall is strongly summer dominant (Figure 1), with high temperatures and high evaporation during the summer months (M'Marete 2003).

The Province has a rapidly growing population, which currently comprises 5.3 million people or 12% of the national population of 45 million (Statistics South Africa 2006). Provincial growth and development strategies are centred on further promoting agriculture, mining and tourism, with agriculture comprising 15% of Provincial GDP and 20% of the workforce. Socio-economic problems persist among the majority rural-based black African population with high levels of poverty, unemployment, HIV-AIDS and problems of infrastructure and social breakdown. Unemployment levels are high in all districts, ranging from 30% in the Waterberg to 70% in Sekhukune (Limpopo Growth and Development Strategy 2005). Other socio-economic indicators, such as dependency, human development and poverty indices and life expectancy (52 years in 2003) all indicate significant and urgent developmental requirements. A range of public initiatives are aimed at addressing these issues, with broad based, black economic empowerment, land reform and small, micro and medium enterprise (SMMEs) development as key strategies.

Like much of southern Africa, Limpopo Province has traditionally had dual agricultural sectors comprising commercial and subsistence based farming systems occupying 15% and 14% of the province's land, respectively (Department of Environmental Affairs and Tourism (DEAT) 2007). The evolution of these two sectors lies in the land and social policies of pre-democracy governments. Post-apartheid reform policies of land restitution and land redistribution have created opportunities for the previously disadvantaged majority population to own and farm land. These new farmers, together with farmers from the subsistence sector who are attempting to commercialise, now constitute a third middle sector locally termed the 'emerging farmer' sector. This third sector has been promoted as a means by which the disadvantaged population might formally engage with the commercial agricultural economy and to share in the financial, social and environmental benefits that this would enable. Whilst much hope is vested in the 'emerging farmer' sector, there are significant barriers to, and few examples of, its success. Some of the more challenging constraints identified by the project team and endorsed by participating farmers are summarised in Table 1. Some of these constraints have been inadvertently created by government policies (e.g. lack of secure tenure for some livestock farmers) and by inadequate delivery of government services (especially technical advice). Other challenges have developed as a result of previous unsustainable land management practices and the large-scale movement of young people from rural to urban areas as they seek better lifestyle opportunities.

Table 3.1. Major issues facing the emerging farmer sector in Limpopo Province.

Livestock farmers	Cropping farmers
Competitive nature of commercial agriculture – efficiency driven, capital intensive, high information requirements. Lack of clear title and uncertain ownership Insufficient farm size to be commercially viable. Poor condition of land and veld resources on most farms Inadequate or damaged infrastructure (including theft and vandalism). Inability to control animal numbers, the keystone of grazing management Limited capital and access to credit compared with commercial intensive systems Absentee ownership/distance from homes Limited technical skill and farming background Fragmented (often contradictory) sources of technical and financial advice Poor access to extension officers—overcommitted and under-resourced Unclear farmer goals and confused leadership—is the aim to be commercial or just own land and cattle?	Low fertility of soils Recurrent droughts and harsh weather conditions Inadequate access to machinery for farm operations Inability to stop animals grazing cropping lands during the dry season Limited capital and access to credit Ageing operators, limited access to labour Limited technical skills and farming background Limited knowledge of market opportunities Poor infrastructure for tillage, grain storage, transport, marketing. Fragmented (or no) sources of technical and financial advice Poor access to extension officers – overcommitted and under-resourced Unclear farmer goals and confused leadership—is the aim to be commercial or just own land and farm for household food.

Notwithstanding the urgent moral imperative of land reform, land claims and the slow process of their resolution continue to have a negative impact on the profitability and sustainability of many commercial operations in Limpopo Province. DuToit (2004) documents many disturbing examples of highly productive commercial farming operations being rendered unproductive within a few years of a change in ownership assisted by land reform policies. There is obviously a failure in the process of land reform which exacerbates tensions within the community and actually increases rural poverty.

Nevertheless, and despite the difficult context outlined above, there are some genuine opportunities for emerging farmers to make advances towards the goal of increasing welfare if not attaining commercial status. Emerging farmers are being provided with incentives, such as opportunities to share resources, co-operative efforts for purchasing better quality inputs, the development of specialised markets for livestock, and bulking up commodities and other farm produce for sale in larger and more uniform lots in order to produce to market specifications. The successful exploitation of many of these opportunities will require, at least initially, outside assistance to further develop and demonstrate the new systems and to build human capacity. The lack of agricultural production, marketing and management skills suited to commercial enterprises of the emerging farmers and their extension support networks simply cannot be overstated. In that sense, insights that might notionally be drawn from conventional participatory approaches to agricultural development based on sharing formal research and local knowledge are more likely to be successful in identifying rather than solving technical problems. Technical capacity building is a critical step in this particular development context.

4 Objectives

The principal aim of the project was to improve the sustainability of emerging farmers who operate in crop and livestock production systems in the Limpopo Province, RSA.

The objectives were to:

1. Develop and promote a range of forage and veld management strategies that assist emerging farmers to match the market specifications for store cattle in Limpopo Province - essentially develop economic feed year plans.

2. Improve the productivity, efficiency and sustainability of crop production in mixed and crop-only emerging farming systems.

3. Build the capacity of the Limpopo DOA and University partners in targeting/facilitating and managing sustainable beef/maize production systems and conducting on-farm, participative research in the rural communities of Limpopo.

4. Build the capacity of beef/crop farmers to run profitable and sustainable farming enterprises.

The intended outcomes in the short to medium term were to improve the profitability of livestock and grain enterprises of emerging farmers. In the longer term, the resource base was intended to benefit in response to the adoption of better land management practices.

A particular feature of this project was the partnerships created between 2 local universities, the University of Limpopo (UniLimp), the University of Venda for Science and Technology (UNIVEN) and the Limpopo Department Agriculture (LDA) and JODEMS Agri-pioneers. A private sector company involved in the grain sector, Progress Milling, was initially included as a formal collaborator in proposals, however little formal interaction with this partner actually eventuated. The project had significant interactions with three other ACIAR projects including LWR2/2000/173 (Dr J. Dimes, crop modelling), AS2/99/036 (Dr H. Burrow, profitable beef) and C2003/120 (Dr P. Carberry, Information and Communication Technologies). These interactions included sharing information and data, sharing training opportunities, joint staff involvement and building on established farmer groups.

The majority of the research from the outset was to be conducted on-farm, collaboratively with farmers in South Africa and Australia. The Australian work which was limited to the first 2 years of the project (2005 and 2006) focussed on extending and scaling up the findings from the on crop/ley pasture/livestock systems tested in AS2/96/149.

5 Methodology

To achieve change in the emerging farmer sector, the project methodology was client focussed with key constraints to farm production and profitability identified and intervention strategies tested and implemented. Based on experiences in AS2/96/149 and other work, targeted capacity building for farmers and LDA research and municipal extension staff was seen to be essential to achieving these outcomes, both during and after the project. The project was, therefore, designed to be conducted predominantly on-farm using participatory action research (PAR) techniques.

5.1 Rangelands

The original project proposal for the rangelands component essentially saw the main objective to be improving livestock production opportunities through improved animal nutrition while maintaining the integrity of the underlying soil and pasture resources. Achievement of this objective was primarily oriented towards the establishment and use of fodder banks centred on the plantings of forage legume spp. On reviewing these objectives, following the visit by the Australian team members to Limpopo Province in February 2005, it was judged as prudent to place a greater emphasis on grazing management, resource monitoring and the rehabilitation of degraded soils and pastures. This, in turn, would necessarily be centred on a wider range of management strategies that are principally more ecological in nature (e.g. spelling, prescribed fire, rotational grazing etc) than the more conventional agronomic options that were originally proposed (e.g. sowing legumes, fodder banks). The proposed methodology for the rangelands component was therefore:

1. Identify and confirm which local communities the project will work with in 2005-2006 and establish functional farmer discussion groups therein.

2. From each of these selected districts, identify 1-2 farms to act as case studies and sites for the location of project-related 'experiments'.

3. Undertake a baseline study of each farm; including such things as: Management objectives, resource base and condition, herd status and performance and financial resources.

4. Prepare maps of the farms including infrastructure, soils and vegetation classes and categorise the various land units into condition or capacity classes:

5. Identify options and design simple experiments for establishment on the case study farms, and possibly other farms belonging to the farmer groups – e.g. simple exclosures, seeding, burning, shrub cutting/chemicals etc.

6. Suggest an overall grazing management system for the case farms – possibly in steps beginning with systems that are consistent with the present resource base and condition with further modification as rehabilitation options either become more apparent or the farmers are prepared to undertake new approaches,

7. Develop a communication and extension strategy that is appropriate to each of the districts and farmer groups.

Similar approaches to this had been effectively employed in S.E. Queensland with specialist cattle producers and eastern Indonesia with smallholder households.

5.2 Cropping

The creation of crop-based emerging farm enterprises through land reform was found to be limited to a small number of horticultural or irrigation based enterprises. The project

focused its activities on smallholder farmers located in the former homelands. These farmers had not obtained access to land through the land reform process, although some will have received some support through the Land Reform and Development (LRAD) scheme to install limited infrastructure (e.g. irrigation) or purchase farming equipment. In Limpopo Province, as there were no dryland cropping farmers identified by the LDA as land reform recipients, it was decided to target smallholder farmers who at least aimed to establish some form of commercialised production. With increasing knowledge of the communities, it became apparent that the project had targeted farmers with varying capacities and desires to make a transition from subsistence based farming to more commercially orientated farming systems.

A simple and practical approach to commercialisation was developed by the teams working with farmers in the Vhembe, Capricorn and Bohlobela districts. This involved a 'strategic pathway' approach for developing capacity to produce and market agricultural products and included in the following steps:

1. Identify the potential market opportunities and benchmark the communities. At each of the cropping study sites outlined above, information was collected through semi-structured interviews about farm area/land types, management practices and productivity, socio-economic characteristics, connections to agricultural produce markets.

2. Undertake strategic research to identify appropriate varieties, agronomic practices and productivity potential of the proposed crops.

3. Build the farmers' (and extension officers) agronomic knowledge and skills in crop production, through formal and in-formal training.

4. Supply or subsidise appropriate inputs such as new varieties and fertiliser.

5. Identify and address other constraints such as storage, packaging and marketing of produce.

6. Provide on-going technical and logistical support.

5.3 Selection of sites and formation of farmer teams:

In selecting farmer groups to work with, the following criteria was followed as far as practical, to select appropriate communities: (i) emerging farmers with an existing commercial focus; (ii) secure land tenure (iii) existence of farmer organisations and networks; (iv) motivated extension officers connected to the community; (v) location and accessibility to the project team.

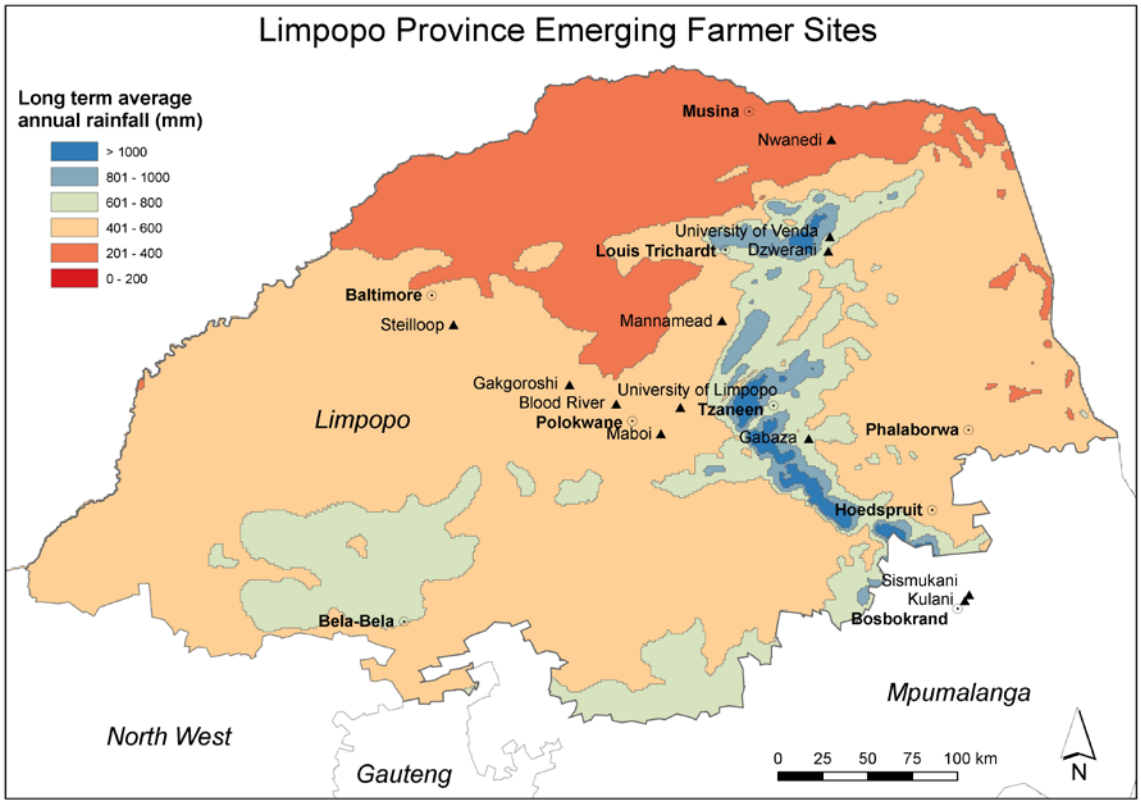

Figure 5.1. The locations of the cropping and rangeland sites.

5.3.1 Rangelands sites:

The 4 sites incorporated within the rangelands/livestock component of the project include Steilloop/Rebone (Waterberg district), Nwanedi (Vhembe district), Maboi (Capricorn district), and Mannamead (Capricorn district) (Figure 1). Steilloop, Nwanedi and Mannamead were initially selected because they reportedly had active farmer groups that were keen to develop forage technologies. Later, the Maboi community farm was added as being of interest to the LDA and having been involved in a previous ACIAR-ARC project (AS2/99/036, profitable beef partnerships). After an initial period of poor management by the LDA, general oversight of activities at all the rangeland sites was undertaken by Frits van Oudtshoorn.

Steilloop/Rebone:

This site is located approximately 120km north west of Polokwane. Soils are mostly sandy loams with the area receiving an average annual rainfall of around 500 mm. Veld at most sites inspected was in moderate to poor condition with considerable bush encroachment. There were 17 farmers in the farmer group, with farms ranging from 1400-1600 ha, running 80-100 breeding cows each. The extension officer for the area was Benneth Ngobeni, based in Mokopane. Three demonstration exclosures were installed for farmer demonstration on Elandsbosch farm, owned by Mr Sekanka, in October 2005. One was on a clay soil, one on a sandy loam, and one on sandy soil. Unfortunately, soon after the exclosures were established, Mr Sekanka passed away, and due to local customs, proper contact with his widow was not possible for 1 year thereafter. Stylo sowings were undertaken on Grootpan farm near Marken (south of Steilloop), owned by Mr Kgatla, and on the farm of Mr Mabelebele near Salt Lake (north of Steilloop). This latter site was resumed by a successful land claim and work at the site immediately ceased. This farmer group had participated in a previous ACIAR project (AS2/99/036 profitable beef).

Nwanedi

This site is located north of the Soutpansburg Mountains on mostly sandy loam soils and receiving an average annual rainfall of 300-400 mm. There were 35 farmers with farms ranging from 800-1700ha, running 40-80 breeding cows. The extension officer for the area is Frederick Nwendamutswu supported by Matodzi Sitholimela. Three demonstration exclosures were erected during 2006, one on Adieu farm, owned by Mr Wilson Muvhulawa, on sandy loam soil, one on veld in poor condition on Laura farm owned by Mr Netangula, and one in Mopani veld on Fallershall farm owned by Mr Ambani. All farms in this region were badly overgrazed at the beginning of the project. Mr Wilson Muvhulawa was also chairman of the northern beef producer group and a National Emergent Red Meat Producers Organisation (NERPO) delegate.

Maboi

This is a single community farm of ~4000ha on granite soil 15 km east of Polokwane, with an average annual rainfall of 500-600 mm. The farm was established under a Settlement Land Acquisition Grant (SLAG) as part of the land reform and restitution process that prevailed early in the life of the post-apartheid land reform process. As Matjieskraal Farm it was previously a large commercial holding with 38 camps, well watered with dams and troughs, with irrigated forage production, a small feedlot, and its own auction yard. This site was added when the Mannamead site was postponed. Three demonstration exclosures were erected late in 2006, although one was never fenced properly. A 2 ha area was sown to stylo and buffel grass in February 2006, however establishment was poor. Subsequently, the community ploughed the area out for sowing vegetables without prior notice to the project team. Also, this farmer group had participated in the previous ACIAR project (AS2/99/036 profitable beef). The extension officer for the Maboi farm was Lucas Masola, but unfortunately Lucas passed away before the end of the project.

Mannamead

This site is located ~60km north of Polokwane on what used to be the Voerkraal feedlot property. This property had been split up into numerous farms of ~300-400 ha each. The farmer group were also members of the northern beef producers group (same as Nwanedi). Initially, project work was postponed at this site due to unresolved issues with land claims and lack of secure titles for any of the participant farmers. Subsequently, an attempt was made to have several demonstration exclosures erected on some of the farms but this never eventuated due to issues within the LDA in terms of securing materials etc. A small sowing of stylos was planted by Frits van Oudtshoorn in 2006. The extension officer for this area was Mukwevho Zacharia.

5.3.2 Cropping sites

Vhembe District:

This work was co-ordinated by Dr Odhiambo from the University of Venda with collaboration from the Dimes project (LWR2/2000/173) and LDA. The village of Dzwerani located in Lower Lwamondo about 18kms south east of Thohoyandou, became the hub of engagement activities with a group of 23 farmers (Figure 1). The local extension officer obstructed progress at this site so the Univen team undertook the field activities directly with the farmers. On-farm activities included simple demonstrations and experiments conducted by the farmers (Maize experiment± nitrogen, maize/groundnut or maize/cowpea intercropping, groundnut or bambara nut experiment ± phosphorus) to replicated on-farm researcher managed experiments (A rotation experiment with maize/maize, fallow/maize, cowpea/maize, groundnut/maize, lablab/maize treatments) and a MSc student (Ms Makhaga) on-farm experiment investigating the effect of nitrogen and phosphorus fertilizer on the growth and yield of maize. Field experiments on the university research farm near Thohoyandou were used for student project work (Mrs

Pauline Mabapa MSc) looking at the effect of phosphorus fertilizer on growth, yield and seed quality of three soybean cultivars and additional rotation legume and lablab seed multiplication work.

Capricorn district:

This work was also co-ordinated by Dr Odhiambo. In the Perkesbult/Bloodriver area less than 20 km from Polokwane (near the township of Shesego) several associations of emerging farmers with links to the Progress Milling depot were engaged by the Dimes ACIAR project during the ICRISAT/ACIAR workshop (Sept 2005). Following meetings with farmers in October 2005, 8 farmer associations expressed interest in trialling new legume crops, and also maize and sorghum varieties and N response. A range of field experiments were established to assess the performance of various legumes and cereals under the soil and climatic conditions in the blood river location and to determine the effect of N and P fertilisers on the growth and yield of the legumes and cereals. A local extension officer, Mrs Monica Moloto, provided some support to the project.

Mopani district:

Mafarana and Gabaza villages: This site was co-ordinated by the University of Limpopo (Prof. Ayodele and Mariga) with assistance from two extension officers based nearby (Mr Willy Manzini and Ms Florence Mashele). The farmers at these villages were predominately engaged in subsistence activities. A small number of the male farmers (including the headman) had enough land and available resources to become more commercially orientated. Farmer meetings and the use of simulation modelling helped to identify that issues of low plant populations and limiting N supply were the primary limitations to crop growth. The theme of the research at this site was around the opportunities to improve the integration of legumes and maize with the central research question: What is the reliability of cash crops versus maize in low N input systems and in a highly variable environment?

Field activities at this site were predominately student based projects with 4 successfully completed honours projects (See Section 8.2) an MSC project completed but not submitted (Mofokeng).

The John Allwright scholar, Ms Rebinah Sasa under took her survey and field research activities at Gabaza during the wet season 2007/08 (see section 8.2).

Bohlobela (Bushbuckridge):

The activities at this site were co-ordinated by Dr Kingsley Ayisi and 2 extension officers based at Thulamahashe with the main goal to enhance food security and income generation among emerging farmers in the Thulamahashe Community through increased and sustainable production of grain crops. The project was located in the Bushbuckridge Local Municipality within the Bohlabela District Municipality. The farmers operated at two different sites within the township, namely, Kulani and Sismukani and the objectives at these sites were to: a) characterise the socio-economic profile of the farmers and their current crop production activities; b) document the biophysical conditions at the project site; c) test the importance of nitrogen and phosphorous fertilizers application in maize and cowpea production on the farmers' fields through farmer-assisted trials; d) identify value-adding technologies that will increase the marketability of grains produced on the farmers' fields; and e) design scaling up future production technologies that will result in improved production, quality and marketability of grain crop following the first year of experimentation.

5.4 Model applications

5.4.1 Whole farm model for the rangelands

A specific objective of the project was to develop a whole farm model to evaluate prospective benefits of proposed management interventions and alternative activities. Based on feedback from the 2006 and 2007 round of farmer training workshops and discussions with municipal extension officers, two existing CSIRO cattle herd models were extended to suit application to emerging farm enterprises by including other livestock (goats and sheep) and different land types, and further modified to include income and expenditure on some cropping activities. The model allows for the selection of different veld types and condition, which determines the carrying capacity of the farm. Animal production is adjusted for veld condition in relation to the number of animals carried versus the estimated carrying capacity. Local information sourced from local agribusiness enterprises was used to calibrate the model; including unit costs and usage of local products for dipping, spraying, drenching, vaccinating etc., the costs of feed supplements, transport, commissions, etc. The model was evaluated by local LDA staff for internal consistency, accuracy and general ease of use before any formal analyses were undertaken. The model determines the monthly feed balance for livestock, and uses animal and crop sales and costs to determine gross margins for each activity (cattle, goats, sheep and cropping) as well as the profitability of the whole farm. This resource should be of considerable use to local extension staff who until now have had limited or nil access to models and other production economics aids.

5.4.2 Use and further development of APSIM

Smallholder farmers in the semi-arid regions of southern Africa face serious challenges to maintain food security, exacerbated by low soil fertility, limited resources to purchase inputs and highly variable rainfall. In this context, crop-soil simulation models have proved to be useful in capturing the interactions between climatic conditions, soil types and nutrient dynamics in cereal based farming systems in Africa and Australia (Carberry et al. 2002). In Africa, the development of the Agricultural Productions Systems sIMulator (APSIM) (Keating et al. 2003) model has been underway since 1985 (Carberry 2005) and has been used in a range of contexts as outlined by Whitbread et al. (2009b). In this project, APSIM was used mainly to extrapolate field results to other sites and seasons. Information needed to run APSIM (soil characterisation, weather records, management practices, crop types and varieties) was routinely collected at most experimental sites.

5.5 Australian component

The Australian component of the project was based in the Border Rivers and Maranoa-Balonne region of SE Queensland, and operated in 2005 and 2006 only. A previous project (AS2/96/149) conducted on the Brian Pastures Research Station (SE Qld), tested a rotational system where a grazed legume pasture rotated with grain sorghum was found to be highly productive in terms of animal and crop production (Whitbread and Clem 2006). In association with Grain and Graze projects then underway in the Border Rivers and Maranoa-Balonne regions, an on-farm and on-station research program was established to demonstrate the value of these systems and to collect more data to support the adoption of grain-graze systems.

On farm sites included: (i) "Retreat" (80 km north Goondiwindi) where adjacent areas of 15 ha of lablab and 15 ha of burgundy bean were planted on Feb 6 2006 into a previously cropped Brigalow soil. (ii) "Kelloway" (12 km east of Inglewood) was sown to 15 ha of burgundy bean on 23 December 2005. Data on establishment, biomass production and persistence were collected.

On-station work included: A trial at the McMaster Research Station, Warialda (Northern NSW) to evaluate the establishment and persistence of winter or tropical legumes sown in association with temperate (summer dormant) or sub tropical grasses. This 12 ha site was planted on June 11, 2006 to three 4ha treatments and several small plot experiments; A major pasture trial was established at Roma Research Station (Roma) (summer plantings 31 Jan 2006 and winter plantings 25 May 2006) to examine the establishment, growth rate, WUE and persistence of the main legume and grass species that are commercially available in the region.

With the resignation of Jacqui Hill in 2006, the relocation of Anthony Whitbread to South Australia in January 2007, and the aims of this work being largely achieved, the results were written up and all resources committed to the African component.

5.6 Extension phase

The challenge at the end of 2008 remained to (i) embed the understanding, knowledge and skills built in the initial phase of the project (2005-2008) into the government services charged with the responsibility for supporting the emerging farmer sector; and (ii) scale out farmer support services and information so that more farming communities (and in time the majority) have the opportunity to become profitable and sustainable.

The methodology for the extension phase was therefore:

1. Complete the on-going field activities/experiments and demonstrations within the Bohlobela, Mafarana and Blood river communities.

At Bohlobela where >50 farmers were planting large areas of grain legumes and maize (>40ha combined) the plan was to showcase the project to the Mpumalanga and Limpopo governments and to encourage them to direct additional resources to similar schemes.

At Mafarana, two research assistants working for the University of Limpopo established field trials in 2008. This field work was to be completed in the wet season of 2008/09 and documented by December 2009. (Lephale. S. Field and laboratory evaluation of cowpea (Vigna unguiculata L) lines for yield and bruchid resistance; Selowa, R.C (MSc Crop Science). Evaluation of early maturing determinate cowpea cultivars in dryland areas of Limpopo Province)

At Bloodriver, Prof Jude Odhiambo from the University of Venda planned to (i) complete the groundnut cultivar trials on P response and water use and (ii) develop a basic manual for farmers on appropriate soil and crop management practices.

2. For the emerging farmer livestock enterprises and the Bohlobela cropping communities, identify and develop realistic strategic pathways that can be exploited by highly resource constrained emerging farmers to move towards commercially viable systems. This process was based on consultations with individual farmers, farmer groups and extension officers from the different regions (e.g. Nwanedi, Steilloop) and utilised the capability of the emerging farm enterprise simulation model that has been developed within the present project. A range of potential management options/steps that are technically achievable and economically viable, will identify opportunities for emerging farmers move towards commercial viability in a step-wise fashion. Local extension personnel were to be trained in the application of both the strategic pathways approach to farm development and the simulation model at a training course in March 2009.

3. Mentor and further build the technical capacity of extension officers (LDA and Municipal authorities) working in the cropping and livestock areas who will then be able to productively engage the targeted farming community and mentor other staff, by conducting training workshops (livestock and cropping themes March/April 2009) that incorporate both theoretical and hands on training and assessment.

4. Develop dedicated extension material for use in training workshops that is directly aimed at extension officers, and can also be used in their future engagement with emerging crop and livestock farmers.

5. Hold a forum with the Limpopo Provincial government and Municipalities to showcase project achievements in assisting emerging farmers, but more critically to demonstrate to policy and decision makers the serious impediments facing the emerging farmer sector and strategies for overcoming them. A special session on practical steps to resolving barriers to advancement of emerging farmers was negotiated for the 2009 Grasslands Society of Southern Africa Congress to be held at Roodepoort in July.

6. Develop an exit strategy so the Limpopo government and Department of Agriculture continue to build support of the emerging farmer sector following cessation of ACIAR project activities. This activity was the aim of activities 3, 4 and 5 above. An aspect of the exit strategy was to develop a plan for ensuring that a seed supply system for the key forage and grain legume varieties (including *Lablab purpureus, Vigna unguiculata* and *Cyamopsis tetragonoloba*) remained available both commercially and in genetic resource centres.

6 Achievements against activities and outputs/milestones

6.1 Initial phase

Objective 1: To develop and promote a range of forage and veld management strategies that assist emerging farmers to match the market specifications for store cattle in Limpopo Province.

no.	activity	outputs/ milestones	completion date	comments
1.1	Provision of legumes that augment natural veld	Literature review of veld management literature. Benchmarking current practices/markets/ herds/veld condition.	June 2006	Literature review completed June 2006 and appears in 2006 annual report.
1.2	Find fodder bank technologies that enable farmers to maintain a higher diet quality for cattle into late autumn/winter	na	na	
1.3	Information to farmers on flexible herd and financial management to match stocking rates to resource sustainability	Extension material development	30.08.09	Multiple training workshops held for farmers in 2006 and 2007. Extension officers involved in several training courses A range of extension material developed and now available.
1.4	Integrated modelling capacity	Integrated analysis tool (IAT) modified and used for scenario testing with farmer groups	27.02.09	A specialised emerging farmer model based on a derivative of existing CSIRO herd models was used as a better option for the emerging farmer context than the IAT.

PC = partner country, A = Australia

Objective 2: To improve the productivity, efficiency and sustainability of crop production in mixed and crop-only emerging farming systems.

no.	Activity	outputs/ milestones	completion date	comments
2.1	Demonstrated potential of forages in maize-beef systems and the factors that contribute to maize being able to utilise soil fertility benefits	Potential lablab, cowpea, groundnut germplasm identified. Seed distribution of best bets. On-farm trials	Annually post-wet season and May 2009	A large range of farmer and researcher managed trials were undertaken over 4 wet seasons at 4 on-farm sites. In addition, student field trial work took place in all years at the University and LDA research stations. Well adapted seed (cowpea, groundnut and OPV Maize) was distributed each season to farmers.

2.2	Fertilizer and other agronomic strategies that enhance production in these highly variable climatic environments	Farmer discussion groups. Implement on-farm experiments	Annually post-wet season	Regular formal and in-formal meetings were held pre- and post wet season - the frequency of interactions depended on the level of commitment shown by the extension services.
2.3	Risk analysis of farming practice options using the existing maize, cowpea, lablab and groundnut modules within the APSIM modelling framework	Collection of APSIM model requirements (soil and climate). APSIM analyses of crop/legume/fertiliser decisions and best bet options	Data updated annually and analyses for pre-wet season discussions	Soils and climate information from all field sites has been collated into soil and met databases. This has been used in a range of analyses (Whitbread et al 2007; 2009 b, d) in production of extension material, training courses and feedback to farmer groups.
2.4	Recommendation for intercropping and relay planting of legumes into maize dominated systems		na	This activity was covered in the AS2/96/149 and was not repeated.
2.5	New legumes evaluated under subsistence and emerging farmer conditions.	Potential new germplasm identified, tested and multiplied. On-farm trials Contract seed multiplication	June 2009	Short season lablab lines have been evaluated over 3 seasons at 3 locations in Limpopo - 5 lines have been recommended for release. Whitbread et al. 2009c contains the description of this work. A large range of cowpea lines were evaluated - seed production of best bet lines took place in 2008/09. In response to interest in growing the industrial legume crop guarbean evaluations took place in 2007 and 2008 to test suitable lines for Limpopo (Mrs Ruth Mkhari MSc UniLimp). One line (cv. Stonewall) was multiplied.
2.6	In Australia, on-farm testing and validation of the best-bet Brian Pastures ley systems	Larger scale plantings of best bet spp. Testing of novel planting techniques. Field days.	31.12.2006	This activity was completed in 2006 with several publications (Hill et al. 2009; Lawrence et al. 2008; Owens et al. 2008; Whitbread et al. 2005; 2009a) covering the science outcomes. Several field days and extension bulletins were also produced to extend the results (Whitbread 2006a,b,c) - burgundy bean and butterfly pea, the 2 main forage legumes identified by this work were commercialised and planted on >100 00 ha by 2007.

PC = partner country, A = Australia

Objective 3: To build the capacity of the Limpopo DOA and University partners in targeting/facilitating and managing sustainable beef/maize production systems and conducting on-farm, participative research in the rural communities of Limpopo.

no.	Activity	outputs/ milestones	completion date	comments

3.1	Improved knowledge of legume/maize cultivation and animal feed plans built upon focussed workshops and ongoing training.	Training of researchers/students and extension staff in data collection, modelling, on-farm research.	Dec 2008	Local university staff are now using a farming systems research approach and addressing issues more relevant to farmers. This has been achieved through the on-going interactions between the team (in the field, annual meetings, conferences and joint papers).
3.2	Enhanced technical and facilitatory skills of key local extension officers at 8 sites	Identify motivated extension officers for each community Technical (veld/herd management; plant production) training courses developed and delivered.	July 2009	Three staff visited Australia for training. All extension officers were involved in planning, presentation of farmer workshops. Much of the training was through the mentorship provided by McDonald and van Oudtshoorn. Formal workshops fpr extension staff reported in section 6.2, extension phase.
3.3	Post-graduate training programs at the universities for 4 students designed to complement the crop, forage and livestock research activities.	MSc (& B.Agric Hons) students identified and project work designed and implemented.	Jan 2010	MSc projects Mabapa, P. Awarded 2009 University of Venda Sasa, R.S. Awarded Jan 2010 (University of Adelaide) BSc (Hons) -awarded 2008 University of Limpopo Chuene, M.M. Tladi, J.M. Lephale, S. Selowa, R.C. As of March 2010 3 MSC student theses were unlikely to be completed (Mofokeng, M. Mkhari, R.& Makhaga). Two MSC projects were being written up for submission (Selowa, R.C. & Lephale, S.)
3.4	Rules-of-thumb and decision-tree guides, combined with a risk evaluation tool, suitable for use by extension staff and other groups, such as NGO networks.	Extension material and course work developed and distributed	Dec 2009	As above 3.1 - see section 10.2.5 for the list of extension bulletins.

Objective 4: To build the capacity of beef/crop farmers to run profitable and sustainable farming enterprises.

no.	Activity	outputs/ milestones	completion date	comments
4.1	Form 8-12 self sustaining farmer teams focusing on profit and sustainable farming practices.	Capacity building of farmer groups. Ongoing on-farm demonstration and experimentation.	Veld sites July 2009 Bohlobela March 2010	At 4 cropping sites and 4 livestock sites, farmer groups were formed with many interactions taking place during the project.

4.2	Increased knowledge of pasture and feed resources, nutrition and feed plans for meeting markets	Cross farm visits Field days and farm walks	Cross farm visits not completed	Attempts were made to organise a cross site visit of selected livestock farmers to several 'successful' farms in North West province that were in commercialising their livestock activities (AS2/99/036). This objective could not be achieved by our LDA partners.

6.2 Extension Phase

Objective 1: To identify and develop realistic scenarios for strategically moving highly resource constrained emerging farmer enterprises towards more sustainable and productive farming systems; and communicate/promote the process for transforming emerging farmers to mainstream agriculture to government and other stakeholders.

no.	Activity	outputs/ milestones	completion date	comments
1.1	In close consultation with local farmers and extension officers, identify a range of viable land and herd management options and develop potential strategic pathways for (i) enabling resource constrained livestock farmers to develop into profitable range livestock enterprises in a logical and step-wise fashion and (ii) shifting highly resourced constrained smallholder cropping farmers to more commercially focused crop production activities.	Milestone 6 Strategic pathways for commercial success identified and viability demonstrated via local case studies involving emerging farmer groups supported by the use of an existing biophysical/economic model. Milestone 7 Build the capacity of a small number (5-10) of management/ extension (technical) staff to undertake whole farm analyses of the production and economic impact of technical interventions for emerging farmer enterprises	Milestone6 30.03.09 Milestone7 30.07.09	Milestone 6: Several strategies were identified where enterprise viability and resource condition could be significantly improved (Section 7.4.1). These have been discussed at length with farmers and extension staff. Milestone 7: Training in veld and animal management and pasture species identification was provided to research and extension staff at Tompi Seleka College in March 2009. Application of feed budgeting and use of the Limpopo Livestock Model was also canvassed at this workshop. Crop production and soil fertility workshops for extension officers conducted in March 2008 and July 2009.

1.2	Completing the on-going field activities/experiments and demonstrations within the Bohlobela, Mafarana and Bloodriver crop-based communities and evaluate the Marken stylo plantings.	Milestone 3 Evaluate the outcome of the crop commercialisation activities at Bohlobela, and promote findings at field day in April 2009. Milestone 4. Establish a fodder bank of Seca stylo (Stylosanthes scabra) on Grootpan farm near Marken with ongoing monitoring and evaluation. Milestone 8. Complete the ongoing crop production field trial activities (Mafarana and Bloodriver), and incorporate the trial results into conference and/or journal articles. Milestone 9. Large quantities of base seed of key varieties of *Lablab purpureus, Vigna unguiculata* and *Cyamopsis tetragonoloba* available in government seed store for supply to seed companies and other project initiatives	Milestone3 27.03.09 Milestone4 30.04.09 Milestone8 30.03.10 Milestone9 30.03.10	M3: A large field day was held in March 09 and attended by the wider Mpumulunga staff - this was part of the exit strategy to facilitate the takeover and replication of these activities. Input support by government occurred in 2008/09. M4: The Marken stylo plantings, even though sown into a fully cultivated seedbed, were not successful due to rapid recolonisation of the seedbed and aggressive competition from the existing grasses in the sward. On the basis of site inspection with the local extension officer (Steilloop) and the farmer it was suggested that future sowing would be aided by pre-treatment of the planting sites with a systemic herbicide (e.g. glyphosate) to reduce competition in the initial year. M8. MSC student Selowa completed field trials at Mafarana in April 09. Prof. Odhiambo completed groundnut x fertiliser P trials at Bloodriver/Dwzerani May09. This work presented at the Sept 2009 African Crop Science Congress and 2010 World Congress of Soil Science. Demonstrations of weed control using tillage or herbicide took place at Bohlobela in Jan-March 2010 in response to reviewers suggestions. M9. Large quantities of seed of several lablab and cowpea lines and one Guarbean line have been stored in LDA facilities for future use -no commercial release of seed was achieved.
	Communicate the key messages from the project to wider audiences within Limpopo Province and nationally within South Africa.	Milestone 10. Presentations made to the Grasslands Society of Southern Africa meeting in a special emerging farmers forum. Milestone 11 Conduct a regional workshop to promote messages to senior Provincial and Municipal government staff (managers and policy makers)	Milestone 10 09.10.09	Presentations have been made on key project findings at the SA National Landcare conference (Polokwane) and GSSA Congress (Roodepoort) in July 2009. The project was also featured in a paper on emerging farmer experiences and options published in the African J. of Range and Forage Science (25/2:71-7). As part of the review October 2009, the MEC and Premier's representatives and senior managers of the LDA attended the presentations and a special closing ceremony. The appointment of Mr Terries Ndove to a very senior post concerned with land reform and famer support is seen as a very positive step in improving government services aimed at supporting land reform.

Objective 2: To develop capacity in the Limpopo Provincial government services to support the transformation of emerging farmers to mainstream commercial agriculture by mentoring and training extension officers and developing dedicated extension material specifically suited to the emerging farmer context.

no.	Activity	outputs/ milestones	completion date	comments
2.1	Develop the capacity of Provincial and Municipal extension (technical) officers in the field application of technical knowledge	Milestone 1 Conduct practical 'hands-on' training workshop on veld management/ restoration principles and techniques with 'in-field' application by participants. Milestone 2 Conduct practical 'hands-on' training workshop on crop/soil management principles and procedures with 'in-field' application by participants.	Milestone1 30.03.09 Milestone2 30.06.09	M1. Dedicated training was provided to LDA and Municipal extension officers in veld and animal management and pasture identification at Tompi Seleka College in March 2009. This was supported by 1 on 1 advice given to local extension officers attached to the project during site visits in October 2008 and March 2009. M2. Crop production and soil fertility workshops for extension officers conducted in March 2008 and July 2009 - these were run by Drs Pengelly and Ayisi.
2.2	In collaboration with provincial and municipal research and extension managers, extension personnel and farmers further develop extension material that has been identified as necessary during the project period. This material will be prepared in the format that has already been developed and tested, which is relevant to the context of emerging farmers, and can be used in training workshops and in future engagements with emerging farmers.	Milestone 5 Five additional technical information bulletins to be completed, printed and used in training activities.	Milestone5 31.08.09	The rangelands and livestock component produced extension handouts on veld management and livestock management which have already been used to support training workshops canvassing these same topics. A companion brochure on budgeting and financial management was produced in collaboration with LDA staff. The material has been used in training workshops, including Tompi Seleka College in March 2009. Brochures covering agronomy and markets of the cash crops guar and cowpea and a forage legume lablab have been produced and printed.

7 Key results and discussion

7.1 Objective 1: To develop & promote forage and veld management strategies that assist emerging farmers to match the market specifications for store cattle.

7.1.1 Objectives 1.1 and 1.2: Stylo introduction

Each of the stylo sowing sites, with the exception of Nwanedi, was inspected in late March 2009. At the Maboi site (Capricorn) there were only a few stylos in the 2 enclosures located close to the homestead, as found the previous year, but there were good populations of both Verano and Seca at the site across the river resulting from the 2007 replanting. Inspections of Mr Kgatla's farm, at Marken (south of Steilloop), showed that the veld was generally in excellent condition due to both good management and good rainfall. Unfortunately the stylo plantings of 2008 were a complete failure due to excessive competition from grass growth (mostly Urochloa). Future plantings using herbicide strips (e.g. as practiced in Australia with Bandseeding) may produce a successful establishment outcome for this context. While row sowings at the Mannamead site have shown a reasonable establishment of both stylo species, there was no evidence of seedling recruitment. The participating farmer at this site has reduced animal numbers and is rotationally grazing as a result of the training course that was conducted 2 years ago which has resulted in a substantial improvement in overall veld condition.

In view of the unfavourable conditions experienced in the 2006 and 2007 sowings, Mr Peter Menne, owner of a commercial farm located near Louis Trichardt, was engaged to test the establishment, seed reset and persistence of the Stylo species under commercial conditions. Site inspections in March 2009 found that the season has been very favourable and there was strong grass growth over the plot area. The Seca stylo is coming back well despite the grass competition, but there was very little Verano as this has to come from seed. Success at this site clearly demonstrates that stylos could have a future in the Limpopo region, but also that establishment is very risky when seasonal conditions are unfavourable and farmers' agronomic skills are limited. Moreover, it remains to be seen if they can persist, especially under the dry conditions that prevail in many districts and the grazing practices that are evident on many emerging and communal farms. There is a considerable role for increased capacity building in veld and animal management to provide emerging livestock farmers with skills in improved pasture management and feed budgeting practices. Hence the increasing priority given to these activities in each year of the project as the extent of the knowledge and skill deficit became more apparent. While there has been a historic reluctance on the part of some South African pasture researchers to embrace augmentation of stylos and other legumes into natural veld pastures, there is continued interest in their application by famers. The project team presented a paper on stylos and their prospective role in boosting pasture productivity to a specialised pastures workshop that was conducted in association with the SA National Landcare Conference (Polokwane, July 12-16th 2009).

7.1.2 Objective 1.3. Production of extension material.

The amount of suitable extension material available to both local extension personnel and emerging farmers in Limpopo province was found to be negligible. Beyond capacity building and training, priority was given to addressing this fundamental gap. Three brochures aimed at extension officers were developed, printed and distributed throughout the Province (Veld Management: The basics; Cattle Management: The basics; Financial Management: The basics)

7.1.3 Objective 1.4. Whole farm livestock production model

A specific objective of the Rangelands component of the project was to develop a whole farm model to evaluate any benefits of proposed veld and animal management interventions or alternative activities. A prototype model - Limpopo Emerging Farmer Model (LEFarM)- was developed in 2006-07 and presented at the 2007 project annual meeting in Louis Trichardt. An updated version of the model was presented to a group of researchers and technicians at Towoomba Research Station in April 2008. On the basis of feedback, which was universally positive, the model has undergone significant further enhancements (e.g. more market options, multiple livestock species beyond cattle) and has been used with considerable success in the capacity building workshops for local extension personnel in March 2009 (Tompi Seleka College). A major advantage of the model, apart from the versatility of using an Excel® platform with which most of the extension personnel are familiar, is the ability to quickly compare and contrast the outcome of many simple parameter changes - difficult to understand when presented verbally without the opportunity for interaction and self-paced learning.

The model integrates animal, pasture and crop production with labour requirements and costs, and evaluates these against existing labour and financial resources. The tool does NOT find an optimal solution for the best strategy. It is up to the user to vary the inputs to determine which combination of farm activities give the best result for their particular interest (e.g. animal production, labour requirements, financial return). In fact, this is a key purpose of the model, to give the user an insight into the impact of particular management or activity changes on farm production or profitability. For example, if the user changes the veld condition, what impact does this have on forage resources, animal liveweight gain, financial return, etc.

The user inputs basic farm information such the veld types and their condition. A veld condition assessment can be done by rating the condition of the basic components of plant cover, soil condition, grass species present (including species identification), bush encroachment, species diversity, and soil type, or an overall assessment can be input. The veld type and veld condition determine the expected carrying capacity of the farm. For breeding herds of cattle, sheep or goats, the herd management strategy with regard to the number of breeders, culling rates, selling age, etc is input. Normal calving rates and mortality rates are indicated, which are then adjusted according to stocking rate versus the estimated carrying capacity. Crop areas, yield and costs are input directly, along with costs for veterinary and animal husbandry , transport, commission fees, and overhead costs.

It should be noted that the absolute values presented may not be completely accurate, but relativity between one scenario and another will be, and this the important factor to compare. For example, if the output indicates incomes of R70,000 and R50,000 for two different strategies, this does NOT mean that a farmer will actually get R70,000 or R50,000 by implementing the strategies. What it DOES mean, is that, financially, the strategy indicating an income of R70,000 will probably be a better strategy than one which indicates an income of only R50,000.

Every time a user changes a parameter and exits an input form, the model recalculates the results. Various results can then be viewed:

FODDER BALANCE – a graph shows the monthly pasture growth, pasture and browse consumption, and the monthly fodder balance. The balance includes any purchased fodder and any crop residue used. This balance is a key indicator of matching stocking rate to carrying capacity.

ANIMAL SALES/COSTS – a graph indicates the number of animals of each category (young males, weaners, etc) sold, as well as total sales revenue and costs. Data on mortalities, potential liveweight gain, probable calving rate, cost of labour, etc. are displayed also. The results for different animal types (cattle, goats, sheep) are displayed separately by selecting them from a drop down menu.

CROPS COSTS – the total revenue for each crop and the costs of labour, seed and fertiliser, etc. are presented.

GROSS MARGINS – tables show the income and costs for each activity (cattle, sheep, goats, cropping) on the farm. If an activity is losing money (i.e. it has a negative Gross Margin) then whether the loss is due to low income, or due to high costs, or both, can be readily seen. Solutions to the problem can then be investigated or, alternatively, it might be better to cease that activity and expand the profitable ones.

ENTERPRISE PROFITABILITY – a table indicates the overall profitability of the farm, after taking into account the overhead costs. It is a sum of the gross margins for each activity, less the overhead costs. This table shows the impacts on the profitability after taking into account the opportunity costs of the farmers own labour and the value of the livestock. Also, this table shows calculations on annual repayments and return on equity for various Debt/Equity ratios.

7.2 Objective 2: To improve the productivity, efficiency and sustainability of crop production in mixed and crop-only emerging farming systems.

As noted previously, the crop based component has generally engaged with smallholder farmers only, rather than with land reform recipients as originally intended. There were no dryland cropping farmers identified by the LDA as land reform recipients, so it was decided to target smallholder farmers who at least aspired to achieve commercialised production. With growing familiarisation of the communities, it was found that the targeted farmers had widely varying capacities and desires to make a transition from subsistence based farming to more commercially orientated farming systems.

In collaboration with locally based LDA extension officers, the project established an extensive program of applied field research activities based around the themes of improving soil fertility, agronomic management and the introduction of cash cropping. These were undertaken with focal groups of farmers in 5 communities: 25 farmers from Dzwerani village, Vhembe district; 8 farmer associations at Perkesbult/Bloodriver in Capricorn district (building on the associations of the ICRISAT-Dimes SMCN/2000/173 project): ~50 farmers from Mafarana and Gabaza villages, Mopani district; 50+ farmers from Kulani and Sismukani in Bohlabela District. The activities include demonstrations, researcher/student trials, farmer experiments, farmer discussion based workshops, field days and farm walks. The results are discussed separately for each region:

7.2.1 Vhembe and Capricorn district

The farmer based activities at Dzwerani in Vhembe district were not continued in 2008/09 (as noted in 2008 annual report) as there was no effective exchange between the farmers, researchers and the local extension officer. While some of this failure might fairly be attributed to a lack of co-operation from the extension officer, the level of motivation for improving farm productivity was quite low for the majority of farmers. Researcher managed on-farm work continued with an experiment on the "Response of Groundnut to Phosphorus Application" repeated at two sites, Matseane II and Dzwerani. This is published as Odhiambo et al. 2010 and summarised as:

Incorporation of grain legumes into existing predominantly maize-based monoculture smallholder farming system may improve the productivity and sustainability of the system. This on-farm researcher managed work had the aim of evaluating the best groundnut cultivar for incorporation into the existing predominantly continuous maize cropping system. Treatments consisted of three groundnut (*Arachis hypogaea*) cultivars (Kwarts, Akwa and Kangwana red) and 4 phosphorus fertilizer rates (0, 15, 30 and 60 kg P ha-1 applied as superphosphate at planting) arranged in a completely randomized block design with three replications. Dry matter was measured at regular intervals and grain yield

determined at maturity. The APSIM model was used to simulate growth and grain yield. Cultivar and P application had no effect on grain yield. Grain yield ranged from 554 to 649 and 1254 to 1503 kg/ha, in 2007/8 and 2008/9 seasons, respectively. A strong relationship (R^2=0.83) was recorded between observed and simulated grain yield. Long term simulation with non-limiting P indicated that 50% of the seasons yielded >506 kg/ha grain. Low rainfall coupled with prolonged drought periods during growing season may have limited the potential response to P application.

At Mmotong/Bloodriver where 4 small communities of farmers (Matseane II, Mokgoseng, Ratanang and Bloodriver) had been growing legumes (groundnuts, sugarbeans, bambara nut and cowpea) to generate income since 2005/06, activities continued. The process has been for the project to distribute seed and fertiliser before each wet season and the farmers plant, manage and harvest the crops. At 3 of the sites (excluding Bloodriver where all the grain was consumed by the households), the crops were harvested, grain bulked with individual farmers receiving ~4 kg for home consumption and the remainder sold locally. Dr Odhiambo's reflection on the process was:

"The farmers rely on the seeds and fertilizer that I give them and therefore only a very limited area can be planted. From this season [2009 when there will be no more distribution] the farmers may not have any legumes to plant. The LDA has not yet made a serious commitment to ensure that once the ACIAR project is over, the farmers will continue with the practice and cover even more area. Severe water erosion and poor soil fertility are major constraints. Weed and pest control measures could also be improved."

7.2.2 Mopani district – Villages of Mafarana and Gabaza and the University Research Station

This site was co-ordinated by the University of Limpopo team with some limited assistance from three extension officers based in the communities. The activities at this site were largely student based on-farm research with 2 MSc projects commencing in mid-2008 (Selowa, C., evaluation of early maturing determinate cowpea cultivars in dryland areas of Limpopo Province; Lephale, S. Field and laboratory evaluation of cowpea (*Vigna unguiculata* L.) lines for yield and Bruchid resistance).

The survey work conducted by students has revealed a situation that is common to many rural communities in the former homelands of Limpopo Province. Tladi J.M. wrote " About 47% farmers from Gabaza were more than 61 years old …only 7% and 20 % of the respondents fell in the 30-50 years category at Mafarana and Gabaza, respectively." Lephale S. wrote that "most of the farmers who are engaged in farming are elderly females. The survey also revealed that most farmers … broadcast seed on unploughed weedy fields ahead of a ploughing tractor. Most farmers (63 %) admitted to poor preparations of their fields…" Further detailed survey and experimental work was undertaken within this community from November 2008- June 2008 by the John Allwright Fellow Rebinah Sasa. Her thesis contains a very detailed picture of these resource poor famers including the demographics, income level and farming practices.

Despite three years of field demonstrations and engagements with these farmers, there are very few that use good agronomic practices. The age of farmers, lack of interest from the younger generation and a lack of mechanisation are major obstacles to improving productivity in most of these communities.

7.2.3 Bohlobela (Bushbuckridge) - Mpumalanga Province

For the life of the project the activities at this site have been co-ordinated by Dr Ayisi of AGES, Ms Busiswe Mashele and Ms Ruth Mashele based out of Thulamahashe (working for Mpumalanga Provincial Department of Agriculture). While the major output at the other 2 cropping sites has been capacity building and testing of technologies, the main success at Bohlobela has been the enhancement of food security and income generation among emerging farmers through increased and sustainable production of grain crops.

More than 50 farmers from the 2 villages have been involved in the project and most have increased their plantings of cash crops, some are using storage bags and a vacuum seal machine (developed by the project) to store and market produce, especially groundnuts and cowpeas. Conclusions from the 2008/09 work included:

Maize grain yield ranged from 1.6 to 3.3 t/ha at Kulani and from 4.8 to 6.6 t/ha at Sismukani, with 75% of the farmers at Kulani producing 2 tons and above. The grain yield recorded in 2007/08 at Kulani was higher than that obtained in 2007/08 at the same location. The relatively higher yields at Sismukani is attributed to higher soil fertility and smaller plot size which enabled farmers to carryout effective weed control. The Bambara groundnut grain yield at Kulani ranged from 1.8 to 3.2 t/ha, whereas cowpea grain yields at Sismukani was between 1.2 and 1.4 t/ha. These are relatively high compared with yields obtained by other dryland farmers at the project site. The total net profit generated by the farmers from the sale of maize, bambara and cowpea ranged from nil to R1954. The farmers at Kulani and Sismukani have demonstrated great enthusiasm and remarkable improvement in the adoption of appropriate agronomic practices which was reflected in the relatively better productivity from their fields compared to many smallholder farmers in the Limpopo Province. With proper management and planning, increased productivity from the farmers' fields could be expected in subsequent seasons.

7.2.4 Guar industry development

In response to interest in growing the industrial legume crop guarbean (*Cyamopsis tetragonoloba* (L.) Taub) the ACIAR project undertook work in 2007 and 2008 to introduce and evaluate suitable lines for Limpopo. There are currently 17 platinum mines sited on Sekhukune land, a district within Limpopo, all of whom use galactomannan in industrial processes and derived from imported product or manufactured synthetically,. Discussions in April 2009 have been held between Anglo Platinum, officials from Development Bank of Southern Africa (DBSA), the National Empowerment Fund (NEF) and a private group, Herbo Sweet farming. The DBSA and NEF will provide 50-50 joint funding on construction of a Guar processing plant proposed by Herbo Sweet farming. Emerging farmers will be expected to have 10-15% shares in the processing plant. Herbo Sweet farming has secured 20% guarbean market share with ARM platinum mining house. Outcomes from these meetings included: the proposed establishment of >300ha of guarbean production unit in 2009/10 growing season; training farmers on guarbean production; and the development of a guarbean association in order to facilitate shareholding aspects in the guar processing plant.

7.3 Objective 3. To build the capacity of the Limpopo DOA and University partners in targeting/facilitating and managing sustainable beef/maize production systems and conducting on-farm, participative research in the rural communities of Limpopo.

Section 8.2 and 8.3 covers this objective in detail

7.4 Objective 4. To build the capacity of beef/crop farmers to run profitable and sustainable farming enterprises

The following discussion uses some examples of where capacity building efforts have led to improvements in profitability and sustainability of the farming enterprises.

Two communities, of >50 resource poor farmers each, have demonstrated through adaptive research that it is possible to transform low-productivity maize-based farming systems into more-profitable enterprises by incorporating grain legume cash crops into rotations with maize. These farmers are now packaging, storing and selling high-value

legume products, when just three years earlier they were barely at subsistence levels of food production.

In rangeland based beef systems, ~ 70 new farmers resulting from government land reform policies have learnt new skills to better manage soil and pasture resources and their beef businesses. Significant outcomes such as the adoption of more sustainable grazing practices including decreased stocking rates and rotational grazing and successes in marketing beef are evidence that on-going efforts to build capacity in local extension staff and farmers and introduce practical and low risk technologies have been successful. Guidelines on assessing the viability of different farming activities allow farmers to evaluate opportunities to take advantage of government programs or cope with changes in market conditions. Limited capacity within the provincial and municipal government agricultural services to support emerging farmers with appropriate advice, input support or infrastructure investment hampers such demonstrated successes being replicated more widely.

7.4.1 Strategic pathway approach to developing better farming systems

Rangelands

A number of emerging farms were surveyed initially to obtain baseline data on their current farming activities, farm size, herd numbers and costs. However, as many farmers do not keep records of costs, much of the information was from memory and contained inconsistencies. Animal data were more reliable and is presented in Table 7.1.

Table 7.1 Cattle and goat numbers for a number of emerging farms in Limpopo province.

Farm	Area (ha)	Bulls	Cows	Steers & Heifers	Calves	Goats	Sales strategy
Moyaha	1580	5	108	0	49	40	Weaners at 7 months
Kgatla	1580	5	103	0	40	80	Weaners at 7 months
Netangula	900	2	60	0	45	30	Weaners at 6-8 months
Wilson	900	2	34	0	24	30	Weaners at 12 months
Morapedi	1670	4	150	0	46	50	Weaners at 6-12 months
Mabelebele	1550	4	90	0	53	200	Weaners at 6 months
Maboi community	4000*	3	61	52	34	0	Auction at 1.5-2 years

*Although the farm was a total of 4000ha, less than 1000ha was available for use for the community herd

Several strategies were identified where enterprise viability and resource condition could be significantly improved through identifying strategic interventions or adjustments to the farming system. These examples highlight the 3 key drivers of farm profit - (i) value of the product (for cattle, R/kg); (ii) product turnover (number of animals sold); and (iii) direct production and marketing costs.

A number of scenarios are presented in Table 7.2 showing the impact of reducing stocking rate to match carrying capacity and the subsequent improvements on veld condition through increased plant cover, better species mix and reduced bush. These in turn inpact on calving rates, cattle sales and gross margins of each cattle activity. The values are indicative for a generic farm of 1600 ha, with an initial herd of 100 breeders, selling weaners at 8 months of age for R15/kg.

The baseline (Scenario 1) assumes a veld in poor condition, as many in the rangelands are, with a subsequent carrying capacity of 18ha per animal equivalent (AE). Feeding during the dry season would be necessary to avoid large losses. The calving rate is low, and the gross margin is comparable to what many emerging farmers are currently obtaining.

Although many farmers do supply bulk feed during the dry season, fully feeding the animals is not profitable, reducing the gross margin to just R10,000 (Scenario 2). Government subsidies for dry season feed alleviate some of this burden, but this encourages poor pasture management. A better option is to reduce the stocking rate (Scenario 3). By reducing the number of breeders to 62, the farm becomes more profitable by increasing calving rates, increasing LWG, and reducing feed costs. The advantage of this strategy is that it increases the farm income without any increase in farm input costs, and at the same time provides some extra capital for the farmer from the sale of excess breeders.

The reduced stocking rate from Scenario 3 would over time as demonstrated by enclosures would lead to better grass cover and the return of some better quality grasses, which would increase the carrying capacity of the veld to 15 ha/AE (Scenario 4) and increase farm income to R114,000. If some of this money was spent on bush thinning, then, over time, the condition of the veld would be further enhanced (e.g. condition score 57) and carrying capacity would increase to 13ha/AE. As the condition of the veld improved, the breeder herd could be increased to match the increased carrying capacity (Scenario 6). With a breeder herd of 85 cows, calving rate would remain high at 79%, annual sales would increase to 65 and the gross margin to R146000.

An alternative strategy would be to avoid carrying stock in the dry season by buying 200kg weaners at the start of the wet season, keeping them for 8 months and selling them before the next dry season. Because the animals are smaller, many more can be carried at the equivalent stocking rate (Scenario 7). Here, 420 weaners are bought at R15/kg, gain weight over 8 months at a rate of 123 kg/annum and are sold at R15/kg, returning a gross margin of R225,000. This looks very impressive, however, there is a risk involved. There are high costs in the form of commission charges (8%) due to the large number of sales, and these amount to R118000. To cover these costs requires a good price for the cattle when sold. If animals were bought at R15/kg and sold at R13/kg, then the gross margin drops dramatically to just R46000 (Scenario 8).

The examples given above show the utility of the model seek out potential options for improving veld condition, animal production and farm financial returns for the rangeland farms of Limpopo.

Table 7.2. Impact of different management strategies on various farm outputs and cattle activity gross margins for a 1600ha rangeland farm. Veld condition - veld condition assessment score (out of 80); Bush - level of bush encroachment; Carrying capacity and stocking rate (SR) in ha/animal equivalent (AE); LWG - potential annual liveweight gain for a steer; farm feed +/- - annual feed deficit (-) or surplus (+) in tonnes for the whole farm; feed costs and gross margin expressed in '000 of Rand (R73k = R73000).

	1 Baseline	2 Full feed	3 Reduce SR	4 Better grasses	5 Bush thinning	6 Increase SR	7 Trade weaners	8 Trade sell @ R13
Veld condition	32	32	32	45	57	57	32	32
Bush	High	High	High	High	Low	Low	High	High
Carrying capacity	18	18	18	15	13	13	18	18
Stocking rate	12.3	12.3	18	18	18	13	18	18
No.cows	100	100	62	62	62	85	400^{W}	400^{W}

Calving rate %	61	62	77	79	80	79	-	-
No.calves	61	62	48	49	50	67	-	-
LWG	123	133	117	127	132	124	123	123
Sales	59	61	47	47	48	65	396	396
Farm feed +/-	-150t	0	0	+120t	+230t	0	0	0
Feed costs	R73k	R137k	R0	R0	R0	R0	R0	R0
Gross margin	R63k	R10k	R99k	R110k	R114k	R146k	R215k	R46k

[W]200 kg weaners

Cropping

In the Bohlobela district, a nationally identified area of poverty, two large farming communities (Kulani and Sismukuni) demonstrated that even resource poor famers can successfully commercialise some parts of their farming enterprises. This region has a large rural-based population with a strong local demand for produce such as groundnuts and cowpea. A simple and practical approach to commercialisation was been developed by a core group of local farmers, and is coined the 'Bohlobela Model'. The strategic pathway for developing capacity to produce and market agricultural products was outlined in section 5.2.

Under the Bohlobela model, a group of South African and Australian researchers gathered information about the current farming system, agronomy and soils from 10 subsistence farmers. Production of the various crop options and the effect of fertiliser and planting dates for the previous 25 growing seasons were simulated using a crop model incorporating local long-term weather records. The results were used to determine the best bet planting times and input levels. This information was communicated to farmers through extension material. Over the first three seasons, the number of farmers actively involved in the project increased to 50. While logistical problems and drought in the initial years resulted in production being too low for a surplus to the household requirements, productivity and enthusiasm of the farmers was increased. In the wet seasons of 2007/08 and 2008/09 increasing numbers of farmers produced enough surplus produce for the packaging and sale of groundnuts to occur.

A key ingredient to the success of the Bohlobela model was the engagement of a well respected and reliable extension officer. This highlights an important issue—every development project needs a local 'champion'. This champion is someone—either local extension worker or respected local farmer—who believes in the aims of the project and who is prepared to put extensive effort into promoting the project and making it succeed Cramb (2000).

Section 8.3 covers this objective in further detail.

8 Impacts

There is strong (albeit largely anecdotal) evidence that the project has already had a positive impact on both scientific and human capacity within the immediate project target areas, but there remains limited tangible evidence of impacts in communities that have not been directly engaged by the project. With the focus of the later part of the project on communication and extension to the broader community of researchers and extension staff, provided that the local government agencies support similar initiatives, it is expected that replication of project success could reasonably occur.

8.1 Scientific impacts – now and in 5 years

This project has already engendered positive changes in scientific practice in several areas outside of the project. Within the collaborating universities, there is a much greater emphasis on engaging with rural communities using participatory research and farming systems approaches (for example all student projects were based in communities as demonstrated in the student project listed below).

The project has influenced the South African veld and pasture management community by highlighting challenges facing emerging farmers at special forums (Grasslands Society of Southern Africa annual congress Grahamstown 2007 and Roodepoort 2009) and through publishing in local journals (e.g. African Journal of Range and Forage Science). This material was judged to be of sufficient importance to lead to a formal and unsolicited invitation to make keynote presentations to the National Landcare Conference (Polokwane 12-16th July).

The practical application of farming and cropping systems models (APSIM and LEFarM) to identify and explore strategies to help resource constrained emerging farmers to effectively manage their efforts and limited resources is influencing the way that other international institutions are undertaking research (Chikowo et al. 2008; Whitbread et al. 2009).

8.2 Capacity impacts – now and in 5 years

8.2.1 Academic achievements

This project has an excellent record of capacity building within the South African University system for both students, as demonstrated by the completions of 2 MSc theses and 5 bachelor degree dissertations listed in section 10.2.6. By undertaking research projects in rural communities, the future career aspirations of these students have been enhanced as evidenced by the students quickly gaining employment in government (LDA) and private companies (Mapfura - Makhura incubator for biodiesel, horticultural manager for Monsanto). The academics involved in the project now have contacts in the rural communities and with local extension services and the confidence to continue their ongoing research programs within these and neighbouring rural communities. The promotion of both university project leaders to Professor is also further evidence of capacity change that can be in part attributed to this project.

8.2.2 Building capacity in extension staff

A range of efforts were undertaken to build capacity within the LDA staff and these were highly valued by extension staff. Most extension staff who have worked with the project are now undertaking MSc level training (supported by a program within the LDA initiated by Prof. Nesumvuni). This is evidence that the project has motivated extension staff to further their careers. Several staff involved in the project have been promoted to senior postings within LDA (Terri Ndove, General Manager of Extension and Rural Development,

Jeffery Mkhari, Senior Manager, Agronomy and Seed Multiplication) and are now able to influence the operation of LDA functions and government policy.

8.3 Community impacts – now and in 5 years

The engagement of at least 300 farmers and their families in 10 communities across 4 districts of Limpopo Province in project activities, including technical demonstrations, researcher-managed trials, farmer-based experiments, farmer discussion workshops and formal training workshops and field days have impacted positively on farmers within the project. Examples include:

1. Farmers at Bohlobela and Bloodriver planting appropriate germplasm and adopting better agronomic practices, resulting in a huge increase in the food output leading to the majority (50+ farmers) improving productivity and several packaging and selling surplus grain.

2. Evidence that some of the participating livestock farmers were now reducing their stocking rates, managing grazing to promote vegetation cover and selling unproductive stock to reduce grazing pressure and increase cash reserves (one example of the strategic pathways approach being promoted by the project). One farmer had commenced planting of legume fodder banks, and others were now seeking planting materials.

While the aggregate numbers of farmers involved in the preceding examples may not seem large, this progress should necessarily be viewed against the state of near-paralysing inertia that confronted the project teams at the time of project initiation.

8.3.1 Economic impacts

Cropping

The project has made some economic impacts on the targeted emerging farmer community. For example, farmers from the Bohlobela community have commenced packaging, storing and selling their produce for cash within nearby communities. The success of this activity should be a strong incentive for other local farmers to emulate. Very high prices presently received for grain crops is an added incentive for adopting the practices. Increasing fertiliser prices in southern Africa is another incentive to adopt legume rotations. Due to this research-induced practice change, (including the provision of good quality seed and subsidised fertiliser inputs) this group of farmers is now producing food crops on a scale and level of productivity that has never been previously achieved. This, in turn, has many spinoffs that include assured food security, some farmers in the community having surplus produce to sell and all farmers having the ability to safely store grain and seed due to a packaging system that the project has developed. The extension phase promoted this success within the Mpumalanga Department of Agriculture.

Rangelands

It is essentially premature to expect major economic impacts to be already evident for the 3 groups (4 if the late start at Mannamead is included) of emerging livestock farmers that the project has been working with. This is partly due to the low baseline level of performance of these farm enterprises for which the strategy of basic training and capacity building was deemed necessary to make further progress. Critically, each of these farmer groups has also been highly constrained by ongoing uncertainty surrounding the tenure of the majority of the participating farmers' land – in the majority of cases, the land titles being held in trust by the LDA which can mandate or veto particular management practices. This situation is a widespread one throughout much of South Africa, and stems from a complex history of displacement of prior inhabitants from traditional lands which has led to an array of competing and conflicting claims over title to a given tract of land.

Until this tenure issue is satisfactorily resolved it is unlikely that many of the farmer participants will invest significant resources, particularly fixed capital and investments in long-lived veld pasture management options, in the strategies that are required to make an impact on their economic well-being. However, through the training that has been provided to both the extension personnel and the farmers themselves, they will be in a strong position to make progress once the security of land tenure is established.

8.3.2 Social impacts

The project has been a catalyst for attracting young South African men and women to pursue studies in agricultural research and extension– especially in the local universities that are collaborating with the project (University of Venda, University of Limpopo). This is an extremely important outcome for future progress in agricultural development for the Province. Attracting younger people to actively engage in farming can also be achieved with time, if it can be demonstrated to them that there is a viable livelihood to be made in farming. This is more likely if they can foresee a successful transition to commercial farming rather than being locked into the less rewarding activities associated with smallholder subsistence farming. A significant social impact has been the empowerment of older farmers presently engaged in the project who otherwise find themselves in a desperate situation, especially those with dependants. With much higher levels of productivity and crop production, there is scope to reap potential health improvements in both the farmers and their dependent families due to better nutrition.

8.3.3 Environmental impacts

In some project areas, there is an increase in the growth of crops largely due to higher inputs and better management. In other areas rotational grazing systems have been introduced and/or stocking rates reduced as the participant farmers obtained a better understanding of the interaction between veld condition and grazing management through the enclosures and training courses. These modified grazing strategies are recognised for their ability to increased pasture biomass due to decreased grazing pressure. Decreased run-off and soil erosion is also a likely positive benefit due to the increase in ground cover for both the crop and livestock groups.

8.4 Communication and dissemination activities

Efforts in communication and disseminating information have been on-going and aimed at a range of audiences. The project gained a high profile from the start because land reform is an exceptionally high profile issue and local government is interested in supporting this work. Keynote presentations have been made at several regional forums (National Landcare 2009) and scientific meetings (2007, 2009). Four annual project meetings have brought together the various project teams to discuss progress and results - from these interactions, project members from the various institutions have collaborated on a range of other work.

8.4.1 Notable Forums

The project launch was held at Gamarotsana at Steilloop (Elim farm), 130 km west of Polokwane. The official party included: High Commissioner for Australia, Mr Phillip Green OAM; Limpopo MEC for Agriculture ME Dikeledi Magadzi; Waterburg Executive Mayor, Cllr. G. Molekwa; Mogalakwena Mayor, Cllr. B. Mmola; Municipality mayor and Councillors; Senior Manager, Waterburg district; Prof Edward Nesamvuni; Director of Proceedings, Mr Mortimer Mannya; Local Chiefs and headmen; 300-400 farmers and other participants. There was substantial media coverage including A. Whitbread interviewed on national radio SAFM and local radio coverage of the event.

Workshop "Are the right questions being asked in fertiliser research for the dry regions of southern Africa" sponsored by ICRISAT, LPDA, CSIRO and ACIAR. August 31 and

September 1, 2005 reconvened after farmer visits on Sept 6. This workshop explored fertiliser recommendations for smallholder farmers through a workshop program where participants act in the role of smallholder farmers faced with crop investment decisions.

Annual project meetings (Start up workshop, 14 March 2005; Annual meetings 4-5 April 2006, 25-26 July 2007 and 14 October 2008) and were attended by most project team members (usually 35+) and senior members of the LDA. The meetings in 2006 and 2007 were attended by 2 cropping and 2 rangeland farmers to gain their input in project planning.

A major field day was held with the Bohlobela farmers (March 25, 2009) to showcase their transformation to more productive and commercially focussed production systems– several awards were made by Anthony Whitbread to local farmers and other project team members including an award to an outstanding female farmer.

Final project meeting and review (Oct 5-9 2009) and closing ceremony (October 9 2009).

8.4.2 Keynote appearances at national events

MacLeod, N.D., McDonald, C.K., Whitbread, A.M. and van Oudtshoorn, F.P. (2009). Challenges for Emerging Crop and Livestock Farmers in Limpopo Province – Further Reflection. Grasslands Society of Southern Africa, 44th Annual GSSA Congress, 20-24 July 2009. UNISA Campus, Florida, Roodepoort, Gauteng.

MacLeod, N.D.,Martin, T.G. and House, A.P.G. (2009). Cost-effective conservation reserves for Australia's broad-acre grazing landscapes – ecological and economic effectiveness? Grasslands Society of Southern Africa, 44th Annual GSSA Congress, 20-24 July 2009. UNISA Campus, Florida, Roodepoort, Gauteng.

McDonald, C.K., MacLeod, N.D., van Oudtshoorn, F.P. and Whitbread, A.M. (2009) Challenges for emerging livestock farmers in Limpopo Province. South African National Landcare Conference 20-21 July, Polokwane South Africa.

McDonald, C.K., MacLeod, N.D., van Oudtshoorn, F.P. and Whitbread, A.M. (2009) Stylosanthes - experiences from Australia and potential in Limpopo Province. South African National Landcare Conference 20-21 July, Polokwane South Africa.

Nesamvuni, E., Mkhari, J.J. and Whitbread, A.M. (2009). Developing a collaboration model for research: A case of the Limpopo. Crop-livestock system Grasslands Society of Southern Africa, 44th Annual GSSA Congress, 20-24 July 2009. UNISA Campus, Florida, Roodepoort, Gauteng.

Whitbread, A.M., Ayisi, K.K., Hargreaves, J.N.G. Sasa, S.R., Odhiambo, J.J.O and Dimes, J.P. (2009). Using simulation to estimate yield potential and design smallholder farming systems for Limpopo Province RSA. African Crop Science Society Congress, Cape Town Sept 28- Oct 2.

8.4.3 Training courses and extension material

Three members of the Veld management team (Lucas Masola, Benneth Ngobeni, and Frits van Oudtshoorn) were funded by ACIAR and LDA to visit Australia to visit a range of beef enterprises, be exposed to local farming systems research initiatives and to attend the Australian Rangelands Society Conference in Renmark, September 2006.

John Dillon memorial scholarship was awarded to Mr Jeff Mkhari for a training visit to Australia March 2007.

Three day training courses held at Steilloop, July 2006, Maboi, December 2006, and Louis Trichardt, January 2007. Each course was attended by 15-30 farmers. Courses were well received and many requests received for continued training. Training material has subsequently been developed.

Extension workshop, Tzaneen, March 12 2008, conducted by Dr Bruce Pengelly (CSIRO), Mr Jeff Mkhari (LDA), Ms Buswise Mashela (MDA), Mr Sankie Lephale (UniLimp). Topic: Key behaviours for extension staff to make an impact + some relevant technical information. 15 Extension staff attended. Co-funded by ACIAR/LDA

Animal and whole farm model workshop, Towoomba Research Station, April 10 2008, conducted by Cam McDonald (CSIRO) and Mr Gerrit Rootman (LDA). Topic: whole farm systems thinking and to obtain feedback from the more experienced people on the adequacy and applicability of the model to local farms and grazing systems. 12 local extension and research staff. Co-funded by ACIAR/LDA.

Veld and grazing management and estimating sustainable animal production. March 25-27, 2009. Tompi Seleka Training College by Mr Cam McDonald and Mr Frits van Oudtshoorn. Attended by 15 extension staff and 2 senior managers. The formal course evaluation indicated a marked improvement in participants' understanding of important grazing management concepts, including effective carrying capacity, feed budgeting, veld restoration and grass species identification.

Crop production and farming systems research and extension: Delivered by Bruce Pengelly and Kingsley Ayisi (JODEMS Agri-Pioneers). This course took place July 20-22 at Tompi Seleka Training College, Limpopo Province South Africa and was attended by approximately 20 handpicked and motivated extension officers who work with smallholder farmers.

Ongoing efforts by Mr John Hargreaves, Dr John Dimes and Dr Whitbread were made to train academic staff in the application of APSIM. A formal training course was held 31 July –4 August, 2006 and attended by Dr Odhiambo, Mrs Paulina Mabapa, Ms N.S. Makhaga (Univen), Mr Patrick Nemakundani (ARC) and Mr Kemedi Matlala (LDA) with follow-ups in 2007 and 2009. Mrs Mabapa and Ms R.S. Sasa (John Allwright fellow) would be considered as proficient in the use of modelling.

An absence of any extension material of direct relevance to emerging farmers available through the LDA prompted the project team to produce several extension brochures aimed at extension officers working with emerging farmers (see section 10.2.5)

9 Conclusions and recommendations

9.1 Conclusions

Despite the end of the apartheid era in the mid 1990s and deregulation of the agricultural sector, the subsistence-smallholder farming sector has largely failed to become part of mainstream commercial agriculture. In the reality of a much more competitive and open trading economy for agricultural products and industrial inputs, and with limited infrastructure and technical support, this failure is not surprising. Much policy hope for more equitable representation of previously disadvantaged people within the commercial agricultural sector is presently being vested in the emerging farm sector. This sector is broadly made up of new entrants to agriculture assisted by the land reform programs or drawn from the ranks of existing subsistence farmers who are attempting to make a transition to commercially based agriculture. The growth in a third 'middle' sector is seen to be an obvious avenue for allowing the mainstream and disadvantaged black African population both to contribute positively to the formal agricultural economy and to share in any financial, social and environment benefits from this change.

There are significant barriers to this successful transition and to date, few success stories. Despite these barriers, the emerging farmer sector does represent a significant opportunity for new farming systems to emerge, particularly for medium-scale enterprises. Opportunities do exist to share resources (e.g. tillage equipment, milling equipment) and co-operative efforts for purchasing better quality inputs (e.g. seed and fertiliser or timely operations using ploughing contractors). Attempts to develop specialised markets for livestock (e.g., indigenous cattle breeds), bulking commodities (e.g. groundnuts) and other farm produce provide incentives to change animal husbandry or cropping practices to produce to market specifications. Most of these opportunities will require that private-public partnerships are formed and, at least initially, outside assistance in the form of development programs (such as this emerging farmers project) to demonstrate and build capacity.

9.2 Recommendations

The following discussion canvases a range of options at the government policy level, within the Limpopo Department of Agriculture and by the emerging farmer.

9.2.1 Government policy

Land reform policy

The processes of land reform are highly sensitive and politicised and have progressed extremely slowly resulting in limited numbers of emerging farmers with secure land reform. Ensuring that the security of land tenure is not threatened by competing land claims is of paramount importance and needs to be addressed quickly to give emerging farmers clear title to their land. Despite the best intentions of some emerging farmers to make the transition to a commercial farmer status, many of the new farms are of insufficient size to be economically viable. For example, livestock farms with carrying capacities below 400 livestock units (LSU – animal with a weight of 450 kg) struggle to survive (ABSA 2003). Many livestock farms in the emerging farm sector have an effective carrying capacity of less than 150 LSU, largely due to their small initial area, and are constrained further by poor land condition (mostly bush encroachment). Such a farm cannot support the needs of the household, and the farmers typically have to seek employment in other regions, further compromising their ability to implement sound farm management. Policy makers must therefore be able to recognize what is economically viable farm size, based on current farm resource condition.

Rural infrastructure and other services

Emerging livestock farmers who are determined to become commercial operators, despite their limited farm size or poor land condition, will need off-farm income generation opportunities. Taking off-farm employment could allow farmers to reduce the number of livestock required to maintain an acceptable standard of living. Emerging farmers in this situation might also benefit from integrated approaches that include the whole community. For example rural communities might benefit greatly from better roads and communication infrastructure which could create improved access to markets or alternative sources of paid employment. Achieving such improvements would require appropriate alliances between rural communities, the Department of Agriculture and other policy agencies. This could allow rapid and effective growth in the emerging farmer sector. Government funded projects should include provision of on-going support services, not just one-off payments. Reducing, or eliminating, subsidies for dry season feed supplements (i.e. bulk feed such as hay, etc.) would encourage better management of feed resources, rather than a reliance on government handouts.

9.2.2 The Limpopo Department of Agriculture

Learning from the past

Over the past 15 years, agricultural research and development projects in Limpopo Province have had a high failure rate (Connolly et al. 2006). Those which have succeeded in achieving their aims should be evaluated for use as guides to framing successful future projects. The essential attributes of the more successful projects have been a high level of community involvement and a strong sense of ownership of the R&D activities by the members of the targeted communities, the project staff and the agency senior managers. Frequent communication between researchers, and extension staff and the community as well as targeted extension activities have also been important ingredients for success. Extension material is usually best developed by combining the research outputs and recommendations with information that places those recommendations in a local context.

Leadership and mentoring

The department needs to address the issue of leadership and mentoring in research and extension. Many managers, whilst often highly qualified, lack experience as managers. Even when they have experience in research and/or extension, due to management commitments, lack the capacity to mentor more junior staff. Appointing experienced research scientists and extension specialists with local knowledge as mentors for junior staff is recommended. It would be productive for LDA, and far more beneficial to farmers, to have 450 extension personnel supported by 50 mentors, than to have 500 extension personnel.

Developing appropriate strategies for the audience

It is recommended that the LDA better recognise the diversity of target audiences and design more appropriate programs for support. Highly resource constrained subsistence farmers need most support in the form of logistics (access to tillage equipment, fertiliser and seed), input subsidisation and basic capacity building. Emerging farmers may need more support in infrastructure development or accessing to markets etc. Training extension staff to recognise and address these difference is required. Using the methodology employed by this project as an example, the development of step-wise strategies for supporting emerging farmers to make the advancement from subsistence farming to commercial status can be undertaken. Extension personnel will need to be adequately resourced and mentored to achieve the planned steps. Success for managers each year should be measured by what steps have been achieved for the farmers, and how many farmers have achieved them, not by simply spending the budget or by appointing large numbers of staff. The LDA will need to identify potential 'champions' in

various districts and direct their initial support to these farmers to demonstrate to other farmers the potential advancements that can be achieved and to motivate those who may be reluctant to take up the challenge of progressing to commercial status.

9.2.3 Farmers

The training courses on veld, cattle and financial management and relevant extension material provide a base from which to develop a way forward. However, while farmers have been exposed to this knowledge, they will need on-going support to successfully apply this knowledge to their own farm. Where farmers lack the education to keep or calculate the necessary records (e.g. animal identification and history, farm expenses, calving rates, etc), then extension personnel (or other farmers) should assist them until they become proficient. Farmer to farmer visits is a powerful tool to motivate farmers and advance new technology or knowledge. The 'champion' farmers can be used for this purpose. Any proposed strategy must provide immediate benefits to farmers and be low risk. Extension personnel need to develop a step-wise 'plan' with each individual farmer outlining the progression of steps required for their particular farm, and circumstances, to make the transition to commercial status. We see two potential starting steps. Selling off dry cows - this has a number of potential benefits: (i) even if replacement heifers are kept, the dry cows will most likely sell for more than the heifers would have, hence no reduction in income; (ii) surplus money can be used to provide dry season protein supplement (NOT bulk feed) to cows or weaners, which will improve the calving or growth rate of these animals, and increase income; (iii) the calving 'rate' will increase, so the number of breeding cows can be reduced without reducing the number of calves produced, so animals will be in better condition due to the lower stocking rate; (iv) reducing the number of breeding cows will reduce the need to purchase dry season bulk feed, thereby saving further costs; (v) cost savings can be spent on repairs to fences, pumps, water troughs, etc and allow camps previously not usable to be used again, or to undertake bush thinning to increase the carrying capacity of the veld. An alternative first step is to sell a number of breeders (dry and wet) and to use the money to buy, fatten and sell younger animals over the growing season. Preliminary analyses have shown this to be potentially highly profitable. This can be done with just a few animals in the first instance (low risk) and increased over time if profitable, and the extra income could be used in the same way as listed above. This has the added advantage of reducing stocking rate over the dry season and thus reducing potential feed costs.

9.2.4 Some comments on the design of future emerging farmer projects

In Southern Africa, there are ongoing changes in land ownership resulting from legal (in the case of RSA) and illegal (in the case of Zimbabwe) government policies. Any future projects in the region will need to deal with a range of factors that influence the potential for project impacts. As a preliminary to project design, it is recommended that there should be a thorough survey and analysis of the status of the ‘emerging’ farmer sector, especially security of tenure, existing knowledge base about farming, extension support, relevant policies and access to financial resources. Project design should aim at: (i) carefully defining the target farmer group (i.e. social welfare Vs commercial potential); (ii) demonstrating impact in well chosen communities (the right farmers and a champion); (iii) scale up by training the right NARES staff and influencing policy and senior officials; (iv) make capacity building and extension material an important component and (v) engage the private sector (input suppliers, services, training) to build partnerships.

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11 Appendices

11.1 Commercialising smallholder farming systems in the Bohlobela District

Agriculture, mining and tourism are key pillars identified by the Limpopo Provincial Government for economic advancement and development in the province. These sectors have made Limpopo one of the fastest growing provincial economies in the country. According to Stats SA, the contribution from Limpopo to the national economy increased from 5.7% in 1995 to 6.5% in 2002.[1] Agriculture thus, has a pivotal role to play in the province and all aspects of the sector. Agriculture's contribution to the provincial economy had largely been derived from the predominantly white commercial sector. Typical of South Africa, the Limpopo province has traditionally had dual agricultural sectors comprising white commercial farmers and a large proportion of subsistence, smallholder or emerging black farmers. The contribution of the black farming sector is hardly recognised despite the massive number of farmers involved and the potential that exist in the sector.

The lack of recognition is primarily due to minimal per capita output as results of several production constraints, including sub-optimal resources, human capital limitation, low level of skills and capacity, lack of information, etc. However with determined interventions, the farmers could be assisted to make meaningful contributions the local economy. It is against this premise that the ACIAR initiated projects at selected communities within the province to improve output of the smallholder farming sector. The report presented here is from the fourth and final growing season results of farmer-assisted projects in Bohlabela District in Mpumalanga (formerly Limpopo province). The project falls under the crop-livestock systems project in South Africa. The main goal of the ACIAR project is to improve the productivity of emerging farmers who operate in crop-only or in crop-livestock production systems. Over the four years of ACIAR's involvement, the farmers were mentored in the cultivation of maize, bambara groundnuts, groundnuts and cowpea. These are common crops grown throughout the community. Historically the crops have been primarily grown for food security to satisfy household consumption needs and very minimal amounts sold within community in times when productivity goes beyond the household needs. The project site is located in a relatively high rainfall area on predominantly sandy soils. Even though, they have constituted themselves into two distinct working groups; the Kulani and Sismukani groups for some mutual cooperation, the day to day activities of the farmers is largely on individual basis.

During the 2008/09 growing season, twelve farmers from Kulani and three from Sismukani were selected to participate in the farmer-assisted trials on their fields. These are farmers who have demonstrated good commitment and improved adoption of production practices in the farming operations. The farmers at Kulani farmed on 1.0 to 2.0 ha of land each, where the farmers focused on relatively small of 5 m X 5 m each.

11.1.1 Objectives

a) To assess grain yield response of improved open-pollinated maize variety on farmers' fields under improved agronomic and minimal nitrogen and phosphorous fertiliser application.

b) To determine yield characteristics of cowpea, groundnuts and bambara groundnut on the farmers' fields.

c) To measure economic gains on the farmers fields.

d) To determine yield levels of diverse cowpea varieties for future incorporation into the grain legume base of the communities.

e) To multiply seeds of existing cowpea variety for subsequent season plantings.

f) To train and review farmers' performance through workshops and field days.

11.1.2 Materials and Methods

Grain production at farmer fields

Twelve farmers from Kulani were assisted in planting maize and a grain legume as sole cultures. The individual crops were planted between December 2008 and February 2009 (Table 1). All twelve farmers at Kulani planted maize, in addition to one or two of the three legumes; cowpea, groundnuts and bambara groundnut. The crops were fertilised at a rate of 30 kg P per hectare and 30 kg N per hectare. The maize cultivars planted were ZM623 and ZM521 which are open-pollinated. Stalk borer was controlled through the application of the pesticide, Buldock.

At Sismukani, three farmers were selected for the trial, where each farmer planted maize in addition to cowpea on a 5m X 5m plot. The cultivar used and inorganic fertilization rates were similar to those from Kulani. Maize was planted at 25 000 plants/ha; groundnut and cowpea at 60 000 plants/ha, whereas bambara was planted at 120 000 plants/ha. The following data were collected: Days to emergence, stand establishment, days to weed control, days to fertilizer application, grain yield of maize, legume grain yield.

Cowpea line trial

Sixteen diverse cowpea lines and a local check were evaluated for agronomic characteristics and grain yielding within the farming community. The trial was established as a randomized complete block design with three replications.

Cowpea seed multiplication

Seeds of a popular cowpea variety, "Local Black Eye" were planted on a quarter hectare area within the farming community and bulk at harvest maturity for storage and subsequent planting in the following growing season. Only two irrigation water were applied during the season due to the relatively high rainfall obtained.

Farmers' field day and workshops

A workshop was organised for the farmers during mid season and field at the end of the season to train and review farmer's performance.

11.1.3 Results and Discussion

Seasonal Rainfall

Maize Agronomic Practices

The main agronomic practices carried out by the farmers at Kulani and Sismukani during the 2008/09 growing season were land preparation, planting, weed control, pest control and fertilizer application. The land preparation and planting date were closely linked as the farmers planted their seeds immediately after completion of land preparation (Table 11.1). Approximately 33.3% of the farmers at Kulani planted in December 2009, 41.7% in January 2009 and the remaining 25% in February. At Sismukani, planting of the crops occurred in October 2008. The seedling emergence percentage was generally good ranging between and 85 and 90 %. This is an indication of improved seed source used for planting. Seedling emergence during this growing season far exceeded the previous

years where the range was between 50 and 80 % with a large proportion of the farmers field (66 %) exhibiting less than 70 percent emergence.

The first weeding of the fields occurred between 27 and 41 days. However, one farmer fertilised the crop at 5 DAP and another one at 66 DAP. The delay in fertiliser application was as a result excessive rains immediately after planting which delayed access to the fields by the farmers. Stalkborer control occurred between 31 and 41 DAP across the two locations. With the exception of fertiliser application, the timing of agronomic practices was generally appropriate indicating the farmers' improvement in adhering to proper crop management practices.

Table 11.1. Maize seedling emergence and the timing of agronomic management at Kulani and Sismukani during the 2008/09 growing season (Days After Planting, DAP).

	Farmer	Planting Date	Seedling Emergence (%)	First Weeding (DAP)	Fertiliser Application (DAP)	Pest Control (DAP)	Second Weeding (DAP)
Kulani	1	15/02/09	90	31	5	37	52
	2	5/2/2009	85	29	27	38	58
	3	16/01/09	85	29	33	32	47
	4*	15/12/09	90				
	5	10/2/2009	90	33	38	33	
	6*	15/12/09	85				
	7	17/01/09	90	33	34	39	43
	8	16/12/09	85	30	66	35	57
	9*	15/12/09	90				
	10*	15/12/09	85				
	11	14/01/09	90	25	32	34	43
	12	20/01/09	90	21	31	31	40
Sismukani							
	13	10/10/2009	90	36	37	41	53
	14	10/10/2009	90	32	39	41	55
	15	10/10/2009	85	41	41	41	54

* Farmers field damaged by water logging

Maize grain yield response

The number of farmers who produced maize to harvest maturity was reduced from twelve to eight as waterlogging conditions caused severe damage to the fields of four farmers during mid-season (Fig. 11.1). However, not all the crops were lost as some farmers were able to harvest produce from the legumes. Grain yield ranged from 1.6 to 3.3 tons/ha at Kulani and from 4.8 to 6.6 ton/ha at Sismukani.

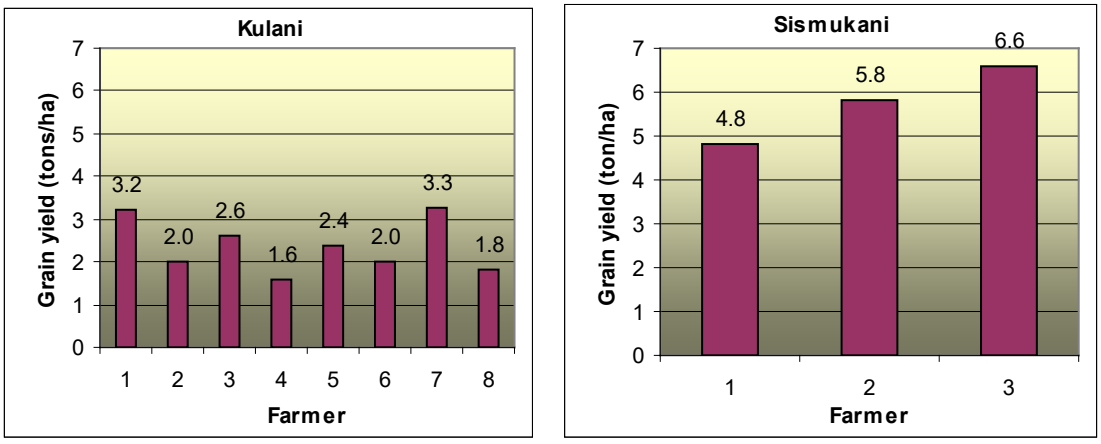

Fig. 11.1. Maize grain yield at Kulani and Sismukani during the 2008/09 growing season.

The higher yield recorded at Sismukani could be attributed to higher residual plant nutrients at the site and also a generally smaller area of cultivation which enabled the farmers to offer relatively better weed control in the field. The grain yields of maize recorded in 2008/09 at the two locations were relatively higher than that of the previous season where majority of the farmers produced between 1000 and 2000 kg/ha. Many smallholder dryland farmers in the Limpopo and Mpumalanga province produce 1000 kg/ha or less grain of maize in their fields, hence, this season's production at Kulani and Sismukani constitutes a great improvement for the farmers.

Legume agronomic practices

Bambara groundnut was the main leguminous crop successfully cultivated by the farmers Kulani during the 2008/09 season, though a small amount of cowpea was produced. This was primarily due poor seed source acquired by farmers. Seven out of the twelve farmers cultivated the legumes with the remaining farmers focusing only on maize. The Sismukani farmers planted only cowpea as this is the preferred grain legume crop at the location. Some of the agronomic practices and response of Bambara groundnut and cowpea is presented in table 11.2. At Kulani, three of the farmers planted the Bambara groundnut during the first half of December, 2008 and remaining four during the first half of January, 2009. Seedling emergence percentage was generally good, above 85 in all the fields. All the farmers carried out the first weeding between 30 and 33 DAP. No second weeding was done in the Bambara fields. Super grow phosphorus fertiliser was applied to the legumes within seven and fifteen days after planting and ridging occurred between 40 and 64 DAP. The crops were harvest between 114 and 117 DAP except one farmer who delayed harvesting until 145 DAP.

Table 11.2. Bambara groundnut and cowpea agronomic activities and grain yield at Kulani Sismukani during the 2008/09 growing season (Days After Planting, DAP)..

Farmer	Planting date	Weeding DAP	Fertiliser Application DAP	Ridging DAP	Harvest DAP	Bambara Yield (t/ha)
Kulani: Bambara groundnut						
1	1/9/09	33	11	64	117	2.4
2	1/15/09	30	7	47	114	2
3	1/10/09	33	8	47	119	2.16
4	15/12/08	31	14	40	145	1.84
5	12/15/09	31	14	52	115	2.16
6	12/15/09	31	15	54	115	3.2
7	12/15/09	31	13	57	115	2
Sismukani: Cowpea						
1	10/10/08	36	37	-	92	1.4
2	10/10/08	32	39	-	92	1.16
3	10/10/08	41	41	-	92	1.2

All the farmers at Sismukani planted during the first week of October, 2008. Weeding and fertilizer application occurred within 32 and 41 days after planting and harvesting was carried out at 92 DAP.

Legume grain yield

The Bambara groundnut grain yield at Kulani ranged from 1.8 to 3.2 tons/ha, with approximately 86 % of the production exceeding 2.0 tons/ha (Table 11.2). The cowpea grain yield at Sismukani was between 1.2 and 1.4 tons/ha. The grain legume yields during the 2008/09 growing season are generally high compared to the typical dryland yields obtained from smallholder farmers' fields within the province.

Economic analysis

Economic analysis was carried out only at Kulani where the farmers operated between 1 and three ha. The analysis was based on sale of harvested produce after a portion of the produce had been reserved for home consumption by the individual families. The parameters analysed were expenditure, income and profit. The total income generated from the sale of cowpea, bambara and maize by the farmers ranged from R470.00 to 2290.00 and a net profit after total expenditure was in the range of Zero Rand to R1954.00 (Table 11.3).

Table 11.3. Income and expenditure analysis of Kulani farmers during the 2008/09 growing season.

Kulani Farmer	Plot Size (ha)	Cowpea	Bambara	Maize	Total	Plough	Disk	Weed	Total	Profit (R.)
		Income				Expenditure				
Madalana L.	2	100	390	1800	2290	168	168	0	336	1954
Mthethwa N.	1	0	1020	0	1020	400	0	0	400	620
Mashaba J.	1	0	0	600	600	600	0	0	600	0
Mashaba J.	1	0	400	800	1200	200	0	0	200	1000
Fakude D.	1	0	400	0	400	0	300	0	300	100
Matsane E.	1	300	700	0	1000	200	0	0	200	800
Mashiloane M.	2	200	900	600	1700	500	120	0	620	1080
Thibela T.	2	200	600	800	1600	0	400	0	400	1200
Mkansi F.	2	200	270	0	470	400	0	0	400	70
Ntusi S.	2	200	1400	0	1600	0	0	600	600	1000
Sibuyi E.	3	200	1900	0	2100	1200	0	0	1200	900
Mlapo V.	2	0	500	0	500	500	0	0	500	0

Cowpea seed multiplication

The seed was multiplied in an area of a 0.25 ha. The total grain harvested was five bags of 65 kilograms each. This translate to grain yield of 1.3 t/ha. The seeds have since been chemically treated and stored. It will be distributed and sold to the farmers, during the coming 2009/10 growing season. It is envisaged that, a bigger area will be allocated for the planting of cowpea, groundnut and bambara groundnut by some selected farmers in the coming season in order to minimise the constraint of seed supply to the farmers.

11.1.4 Conclusions

Maize grain yield ranged 1.6 to 3.3 t/ha at Kulani and from 4.8 to 6.6 t/ha at Sismukani, with 75 % of the farmers at Kulani producing 2 tons and above. The grain yield recorded in 2007/08 at Kulani was higher than that obtained in the 2007/08 at the same location. The relatively higher yields at Sismukani is attributed to higher soil fertility and smaller plot size which enabled farmers to carryout effective weed control.

The Bambara groundnut grain yield at Kulani ranged from 1.8 to 3.2 t/ha, whereas cowpea grain yield at Sismukani was between 1.2 and 1.4 t/ha. These are relatively higher yields compared to yields obtained dryland farmers within the project site.

The total net profit generated by the farmers form the sale of maize, bambara and cowpea ranged from zero Rand to R1954. The farmers at Kulani and Sismukani have demonstrated great enthusiasm and remarkable improvement in the adoption of appropriate agronomic practices which was reflected in the relatively better productivity from their fields compared to many smallholder farmers in the Limpopo Province. With proper management and planning, increased productivity from the farmers fields is expected in subsequent seasons.

11.2 New Cowpea germplasm evaluation

Location: Farmer's field at Thulamahashe in the Bohlabela district, Bushbuckridge.

Objective: To determine the agronomic characteristics and grain yield potential of diverse cowpea lines for future incorporation into the grain legume base of the communities.

11.2.1 Materials and methods:

Land preparation: Ploughing and disking

Fertiliser application: 30 kgP/ha as Super Grow, Cattle manure at 2 t/ha

Experimental design: RCBD with 3 replications

Treatments: 14 introduced University of Arkansas cowpea lines and 2 local controls (Local control 1 which is not widespread, and Local control 2 which is very popular among the farmers)

Plot size: 10m by 1.8m with 2 rows per plot

Planting date: 20 November 2008

Planting density: 60,000 plants/ha

Irrigation: Twice at 22 December 2008 & 8 January 2009

Pest control: Aphids with Buldock

Weed control: Manually, twice during the season.

Harvesting: By hand

11.2.2 Result

Agronomic characteristics

A wide variation in seedling emergence was observed among the cowpea lines evaluated, ranging from 55 to 96.7 % (Table 11.4). With the exception of the local control which only flowered at 93 days after planting (DAP), days to flowering among the lines were similar, with a range of 46 to 52 (DAP). The flowering date is similar to results obtained from most cowpea trials in previous seasons and locations in the province. A wide variation in days to physiological maturity was observed among the lines evaluated, ranging from 77 to 131 DAP. The early maturing ones were Purple Hall Cream, Zipper Cream and UAPB-2, which matured within 77 and 82 DAP. The Local Control 2 was the longest duration type, with a maturity of 131 DAP.

Table 11.4. Agronomic characteristics of cowpea lines evaluated at Thulamahashe, Bushbuckridge in the 2008/09 growing season.

Cowpea line	Seedling emergence (%)	Days to flowering (DAP)	Days to maturity (DAP)
L.A.Purple Hull	97	50	98
UAPBP-1	92	51	101
Early Scarlet	60	48	92
Arkansas Black Eye Pea	88	46	103
Top Pick Pink Eye	77	51	92
Empire	65	52	105
Local Control 1	55	52	101
Purple Hull Cream	87	46	77
UAPBP-2	70	51	82
Early Acre	88	51	92
Zipper cream	90	48	77
CT Pick Eye Purple Hull	68	47	98
Coronet	80	48	105
California Black Eye-5	55	49	92
BVR	63	47	98

Local Control 2	70	93	131
Lsd(0.05)	ns	18	13

Grain yield

Grain yield among the cowpea lines ranged from 0.17 to 1.9 t/ha (Table 11.5). The high yielding lines were Coronet and Arkansas Black Eye Pea with a grain yield of 1.9 and 1.67 t/ha respectively. Grain yield of 50% of the lines exceeded that of the best local type (Local Control 2) grown by the farmers. Yield of most of the lines are also higher than what is typically harvested from farmer's fields within the community. These will therefore require further attention in order to promote and introduce them to the farmers. This will offer the farmers a variety of choice for production in future seasons. The number of grains per pod ranged from 11 to 20 with about 70 % having between 14 and 17 grains per pod. The number of seed per pod did not necessary influenced the grain yield per unit area.

Table 11.5. Yield and yield component of cowpea lines evaluated at Thulamahashe in the 2008/09 growing season.

Cowpea line	# of seeds/pod	Grain yield (t/ha)
L.A.Purple Hull	17	0.7
UAPBP-1	15	1.3
Early Scarlet	13	1.23
Arkansas Black Eye Pea	15	1.67
Top Pick Pink Eye	15	1.03
Empire	11	0.73
Local Control 1	17	0.17
Purple Hull Cream	15	0.77
UAPBP-2	15	1.1
Early Acre	20	0.63
Zipper cream	14	1.17
CT Pick Eye Purple Hull	15	1.23
Coronet	11	1.93
California Black Eye-5	14	0.63
BVR	15	0.47
Local Control 2	12	0.9
(Lsd(0.05)	7	0.49

The distribution of grain yield indicates that, a large proportion of the cowpea lines (74.5%) yielded between 0.5 and 1.4 t/ha and 50 % above 1 t/ha (Fig. 11.2).

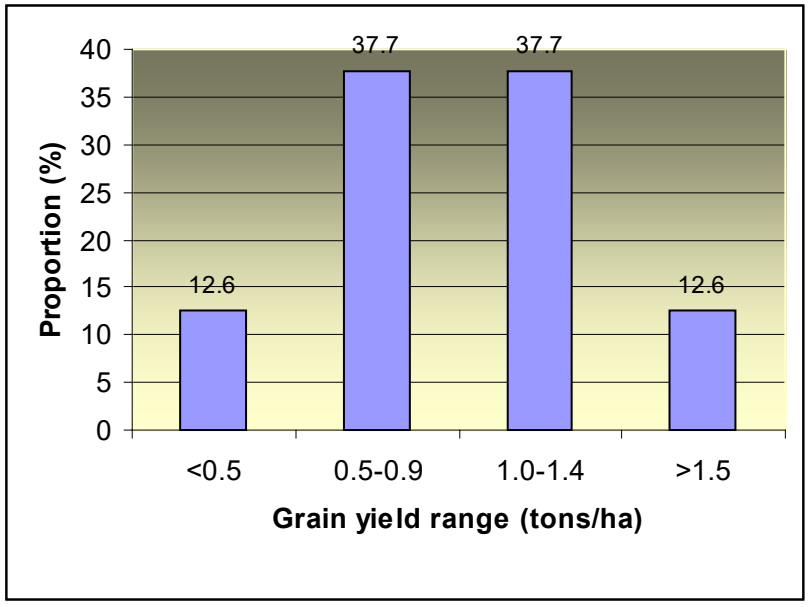

Fig 11.2. Grain yield distribution of cowpea lines evaluated at Thulamahashe, Bushbuckridge in the 208/09 growing season.

11.2.3 Conclusions

Great variation in grain yield exist among the cowpea lines with Coronet and Arkansas Black Eye Pea producing the highest grain yield of 1.9 and 1.67 t/ha respectively.

The common number of grain per pod among the lines was 14 to 17 and this parameter did not influence grain yield.

The time to flowering among the lines ranged from 46 to 52 days after planting and that of physiological maturity was between 77 and 105 days after planting.

The popular cowpea type, Local control 2 grown by many farmers flowered late season after 90 days and matured in 130 day after planting.

The introduced lines Coronet and Arkansas Black Eye Pea will need further attention for promotion and introduction to the farmers in subsequent seasons due to their high yielding potential.