

# **EXECUTIVE SUMMARY**

## **PROJECT BACKGROUND**

This WRC project (K5/1477//4) entitled '*Best Management Practices for Smallholder Farming on two Irrigation Schemes and Surrounding Areas in the Eastern Cape and KwaZulu-Natal Through Participatory Adaptive Research*' was commissioned by the Water Research Commission in 2004. Its main objective was to carry out research in Zanyokwe and Tugela Ferry irrigation schemes with a view to develop and implement technologies and knowledge useful for farmers in order to improve their livelihoods and those of surrounding communities. The project was a collaborative undertaking by five institutions namely: the Universities of Fort Hare, KwaZulu-Natal, Zululand (which withdrew in 2006), and Pretoria, as well as Zakhe Agricultural Training Institute. It was conducted in the form of two case studies based in Zanyokwe Irrigation Scheme (ZIS) which uses sprinkler irrigation and Tugela Ferry Irrigation Scheme (TFIS) which uses a short-furrow irrigation system. The University of Fort Hare team was responsible for work in ZIS as well as coordinating the entire project. The KwaZulu-Natal team was responsible for work in TFIS. The University of Pretoria team provided engineering and irrigation water management expertise to the resident research teams at the two schemes. Participatory research methodologies were employed where the smallholder farmers and other stakeholders were involved in project activities from the initial stage to the end. During year one of the project a detailed situation analysis was carried out at the two selected irrigation schemes to determine the reasons for their poor performance through participatory analysis and evaluation of the social organization, institutional framework, infrastructure, natural resources, markets, livelihoods and farming systems. This was followed by a stakeholder workshop held in Pietermaritzburg in August 2005. The workshop discussed the findings of the situation analysis and identified four key constraints at the two schemes that needed to be addressed in order to achieve increased productivity. These were weak or poor institutional arrangements, lack of stable markets, dysfunctional irrigation infrastructure, and poor crop management. An action research program was then developed, aimed at gaining a better understanding of the underlying causes of the constraints and ways to address them. A summary of the project findings is presented hereunder.

## **WEAK INSTITUTIONAL AND ORGANISATIONAL ARRANGEMENTS**

The situation analysis conducted at the beginning of this project in 2004 revealed that most of the problems at ZIS and TFIS were institutional and related to governance of the schemes. Both schemes had very weak organisational and institutional arrangements. Therefore, any revitalization of the schemes hinged first and foremost on the strengthening of farmer organisations at both schemes. The organisational structure at ZIS was the Zanyokwe Agricultural Development Trust (ZADT) while at TFIS farmers in each of the seven blocks were organised into farmers' associations affiliated to a scheme-wide umbrella committee. Both organisations were largely ineffective and did not ably discharge their responsibilities, which negatively affected productivity and overall performance of the two schemes. The ineffectiveness of the farmer organisations was partly attributed to the fact that the organisations were trying to manage all issues at the schemes, i.e. the water, land, and infrastructural issues as well as farming related activities like mechanization, procurement of inputs and lobbying for produce markets, contrary to an established best practice of having separate management of infrastructure and farming related matters. To address this shortcoming, the project team worked with DWAF to form Water Users' Associations (WUAs) at both schemes to specifically deal with the management of water and infrastructure functions. For the management of farming related activities in ZIS, four primary cooperatives were registered and two were at advanced stages of registration at the termination of the project. In addition, a central Farmers' Cooperative for ZIS was established to take the place of ZADT which had to be disbanded due to its ineffectiveness. In Tugela Ferry, a decision was taken to revive the defunct Msinga Vegetable Producers Cooperative (MVEPCO), to serve as the umbrella body responsible for managing the farming related functions. The main responsibilities of the central co-op in ZIS and MVEPCO in TFIS are to organise markets for various products, purchasing inputs as well as to solve problems experienced by primary co-operatives. These organisational structures were in formative stages at the time project activities terminated, so their long-term impact will depend on conclusion of the formative processes and ensuring their continuation.

Land tenure was a major institutional challenge at the two schemes. It was particularly serious in Zanyokwe where insecure land tenure arrangements are limiting access to land and undermining interest and commitment to farming. Zanyokwe has at least 3 types of tenure systems: freehold (landowners), quitrent (pay rent to magistrate) and right to occupy (communal under traditional leadership). Farmers on quitrent and 'right to occupy' land tenure arrangements have no sense of ownership and hardly invest in new technologies. While the project team tried to address the problem during the lifespan of the project, no headway was made in solving it by the time project activities were terminated. There is thus an urgent need to develop policy on land tenure that would favour

those interested and capable of farming so as to improve on productivity and overall scheme performance.

### **SOCIO-ECONOMIC CONSTRAINTS**

Farmers at both ZIS and TFIS cited lack of capital and stable markets as major socio-economic problems at the schemes. The lack of capital is due to the fact that most households in Zanyokwe and Tugela Ferry earn incomes below the poverty line and thus have limited capacity to invest in their farming enterprises. To compound the problem, they also have limited or no access to credit because credit facilities tend to be available from big and well-structured financial institutions that do not cater for small scale producers allegedly because of the prohibitive cost of managing many small loans. In addition, they also lacked the security and collateral required by these financial institutions. This means that farmers cannot invest in necessary farming inputs or hire labour, which inevitably affects their productivity. Farmer organisations at the schemes need to explore ways of accessing credit facilities through micro-finance institutions that are better equipped to serve clientele without the security and collateral required by bigger financial institutions. Lack of stable markets was singled out as significantly contributing to poor scheme performance at both ZIS and TFIS, and therefore an important leverage point in improving performance at the schemes. The underlying causes for the market instability included poorly organised markets, unsatisfactory marketing services provided by middlemen, informal marketing contracts, lack of pricing standards and poor state of infrastructure related to marketing (roads, storage facilities, etc.). Analysis of the different weaknesses in the marketing process led to the participatory adoption of a two-pronged strategy for addressing the marketing problems. This involved the immediate addressing of problems whose causes were known followed by a study to unravel the less understood causes. One action that was immediately taken was the strengthening of management structures of both schemes as articulated above. The strengthening of farmer organisations gave farmers the collective strength they needed to influence markets to their advantage. This intervention has started to bear fruit in that a major change in the area of marketing was observed whereby the number of farmers involved in collective action marketing in Zanyokwe improved from less than 20% in 2005 to 83% in 2008. The marketing study revealed that production at both schemes was not informed by demand and quality standards were not adhered to. The project intervened by conducting capacity building workshops at both schemes which, coupled with a number of 'look and see' visits to different market outlets, helped farmers appreciate the importance of: (i) market-linked crop production planning; (ii) careful planning of production to ensure regular supplies and avoid surpluses; (iii) grading and good produce quality in achieving good prices and regular sales; (iv) knowledge of alternative marketing channels; and (v) market information including times of the year when different products fetch higher prices at the market. In response to these interventions, farmers have started adopting cropping patterns that reflect market demands and their production is now generally profit driven. In the case of ZIS, farmers have shifted emphasis from grain maize to more butternut and green maize production because these products fetch higher prices. They also perform extra marketing functions such as grading of butternut, which is earning them higher prices. A secondary benefit is that as a result of the profit drive sparked by better and profitable marketing arrangements there is increasing interest among farmers to learn improved crop husbandry practices so as to produce more and improve profits.

### **INFRASTRUCTURAL AND WATER MANAGEMENT CONSTRAINTS**

The water use studies at the two schemes focussed on two things: (i) the infield irrigation systems and (ii) in-field irrigation management. An audit of the in-field irrigation infrastructure revealed that both ZIS and TFIS were experiencing a number of infrastructural problems. Problems at ZIS included missing hydrant pipes, leaking sub-main pipes, uneven stand pipes and malfunctioning valves in certain parts of the scheme. Farmers also lacked skills to do system trouble shooting as well as basic equipment and system maintenance. The TFIS had problems with the water canals, which were not regularly repaired and maintained. These problems seemed to be partly a result of the fact that the decisions to form the schemes and their implementation were top down and farmers had limited or no say. Subsequently, no effort was made at both schemes to capacitate farmers to a point where they could claim ownership of the infrastructure and consider it their responsibility to maintain it. This needs to be done if sustainability of the schemes is to be achieved.

The in-field water management work at ZIS involved installing and monitoring responses to wetting front detectors (WFDs) at two farms. The responses of the detectors recorded at the two farms clearly reflected differences in the soils at the two farms. At both farms the shallow detectors responded most of the time while the deep detectors responded only occasionally after irrigation or a rainfall event of more than 20 mm. These results indicated that WFDs can help to make irrigation management tangible and realistic to farmers and extension officers. Observations made during the summer season indicated that the current irrigation scheduling at Burnshill-East of approximately 9 mm of

irrigation applied every four days to the crop was inadequate to meet peak water requirement of cabbage and butternut. The results also revealed that farmers needed to be assisted to align irrigation scheduling with the water requirements of the crops and the irrigation equipment available.

In-field water management by the farmers at the Tugela Ferry Scheme was done through irrigation system evaluations and irrigation monitoring with wetting front detectors. Results obtained indicated that water was applied inefficiently to crops, particularly with regard to distribution uniformity. This could affect crop yield as crops may in some cases be under-irrigated and in other cases over-irrigated, leading to low irrigation efficiencies and water loss. Water allocation among farmers was also found to be a problem as some farmers used larger volumes compared with others, making the water less available to other farmers. The results also indicated a need for the maintenance and cleaning of sub-canals to be scheduled such that all farmers utilising a certain sub-canal clean or do maintenance at the same time for the whole sub-canal, not just in front of their own plots. This would minimise instances where a farmer clears his portion but in the end the volume of water reaching his/her plot is minimal. A cost benefit analysis of using balancing dams located at block 4 of TFIS was undertaken to determine if money would be saved if the pump was operated during the night to fill the balancing dams, from which irrigation could then take place during the day. The scenarios compared were: 1. The current situation – water is pumped from 06:00 to 15:00, Monday to Friday, 2. Water is pumped from 06:00 to 15:00, Monday to Saturday, and 3. Water is pumped from 22:00 to 07:00, Monday to Friday, and 4. The current situation (scenario 1) but using a diesel engine to drive the pump (diesel price = R10/litre). The results showed that the current practice (scenario 1) had the highest unit cost of electricity (R0.40/kWh) while scenario 3 had the lowest cost per unit of electricity (R0.22/kWh), which could result in an annual electricity cost saving of R26489.51. The use of diesel as an alternative energy source proved to be completely unaffordable at R3.85/kWh. Generally, work done at the two schemes revealed that there is plenty of scope to increase water productivity at Tugela Ferry and Zanyokwe irrigation schemes. Addressing the identified infrastructural needs and ensuring that irrigation water is available and effectively distributed through the irrigation scheme should be given top priority. The second priority should be to introduce user friendly irrigation scheduling tools like the wetting front detector, which helps the irrigator to decide when and how long to irrigate.

#### **AGRONOMIC CONSTRAINTS**

The situation analysis showed that both cropping intensities and crop yields were low at ZIS and TFIS, but the situation was worse in ZIS. Therefore, among other things, this project sought to answer the question whether an improvement in agronomic management of crops would result in higher productivity levels despite the state of irrigation infrastructure and other constraints. Constraint analysis showed that the main agronomic factors constraining productivity were basic management practices such as weed, water, fertiliser and plant population management, late planting, and choice of cultivars, all of which were within the farmers' abilities to control. When these issues were addressed by the project team yields improved substantially as summarized below for the two schemes.

#### **Technological options for addressing agronomic constraints at ZIS**

*Exploratory trial on the effect of planting time, fertiliser rate, plant population and variety on maize (Zea Mays L.) grain yield at ZIS:* This study was conducted to explore issues that needed research attention at ZIS with a view to provide a basis for guiding the agronomic research agenda. The results showed that of the four factors tested, planting time, followed by N rate, were the most important factors determining grain yield in Zanyokwe. Higher yields were obtained when maize was planted early and fertilised at 250 kg N ha<sup>-1</sup>. The short-season cultivar, DKC 61-25, yielded optimally when grown early at 90 000 plants ha<sup>-1</sup> whilst the long-season cultivar PAN 6777 performed better at 40 000 plants ha<sup>-1</sup>. PAN6777 was more sensitive to reduced rates of N fertilisation than DKC61-25.

Generally, new hybrids yielded 50 to 65% more than the cultivars commonly grown by farmers. These results clearly indicated that low crop productivity at ZIS was partly a result of inappropriate agronomic practices. Although the focus of the research was on dry grain maize, interaction with farmers revealed that they were more interested in green mealies, hence the subsequent studies focussed on green maize production. *Effect of row spacing and post-emergence reduced dosages of atrazine on weed growth and maize (Zea Mays L.) yield in Zanyokwe irrigation scheme, Eastern Cape:* The objective of this study was to determine the relationship between row spacing and herbicide dosage on weed dynamics and on green and grain maize yield. The results obtained demonstrated the possibility of incorporation of reduced herbicide dosages (RHDs) and narrow rows in small-scale farming systems as an integrated weed management strategy. However, this will depend largely on the weed spectrum in a particular locality. Planting maize in narrower rows than the traditional 0.9 m reduced weed growth and fecundity compared to wider rows. Integration of narrow

rows with reduced herbicide dosages did not result in superior weed control compared to the use of narrow rows or reduced herbicide dosages in isolation. The results of this study suggest the possibility of developing a weed management system based on the use of RHDs, to slow down or stop weed growth soon after application. This strategy will reduce the competitiveness of weeds, without necessarily killing them, before full ground cover by the crop canopy.

*Effect of row spacing and plant population on weed biomass and maize (Zea mays L.) grain yield at Zanyokwe irrigation scheme, Eastern Cape:* The objective of this study was to determine the relationship between inter-row spacing and plant population on weed biomass and on maize yield. The results obtained demonstrated that increasing population above farmers' practice of 40 000 plants/ha to 60 000 plants/ha resulted in more marketable green cobs and up to 30% higher grain yields. Maize yield response to narrow rows could only be realised when maize was grown at a higher population (60 000 plants/ha in this case), but not at lower populations (40 000 plants/ha in this case). At the higher population, grain yield increases of up to 11% could be realised with the use of narrow rows. Narrow rows reduced above ground weed dry matter and hence competition through earlier canopy closure. Plant population was found to have no effect on weed growth and development. It is recommended that farmers at ZIS should plant their maize at 60 000 plants ha<sup>-1</sup> in narrow rows of 45 cm to reduce weed competition and optimise maize yield.

*Effect of pre-plant weed control, plant density and nitrogen on weed growth and butternut (Cucurbita moschata Duchesne) yield:* The objective of this study was to investigate the relationship between N rate, population density and pre-plant weed control on weed biomass and butternut yield. Pre-plant weed control resulted in a six-fold decrease in weed biomass, whereas increasing plant density from 10 000 plants ha<sup>-1</sup> to 30 000 plants ha<sup>-1</sup> decreased weed biomass by 47%. No marketable fruits were obtained when planting was done without prior weed control. Yield increased significantly ( $p < 0.01$ ) with increase in plant density, and the optimum density was estimated to be 25 000 plants ha<sup>-1</sup>. Yield increased with N rate; the rate giving the highest marginal rate of return (MRR) was 120 kg N ha<sup>-1</sup>, which gave a yield of 26.7 t ha<sup>-1</sup>. To optimise on butternut yield, population density should be increased from farmer practice of about 13 000 plants/ha to about 25 000 plants/ha. This study has demonstrated that the low butternut yields obtained by farmers in ZIS may be attributed to poor weed control, nutrient deficiency and low plant densities. Of the three factors, pre-plant weed control is the most important factor as it resulted in 100% marketable yield reduction when not carried out. Pre-plant weed control to kill the first flush of weeds is, therefore, a prerequisite to successful butternut production.

*Comparative response of direct-seeded and transplanted maize (Zea Mays L.) to nitrogen application:* Transplanting can help in achieving a good plant stand which would translate to more green cobs and higher grain yields. However, there was lack of information on N fertilizer rates for transplanted maize. Therefore, this experiment evaluated the relationship between nitrogen rate and maize establishment method (direct seeding vs. transplanting of seedlings) on green and grain maize performance. Transplanting resulted in a significantly higher crop stand of 96% compared to direct seeding, which achieved 78%. Transplanted maize had shortened growth duration in the field, reaching flowering stage 11 to 15 days earlier than direct-seeded maize. At low N rates, transplants produced higher green cob mass, grain yield and longer cobs than direct-seeded maize. The economically optimum N rates required to obtain marketable cobs were 149 and 98 kg ha<sup>-1</sup>, whilst those required for achieving optimum grain yields were estimated at 240 and 227 kg ha<sup>-1</sup> with direct seeding and transplanting, respectively. The findings suggested that transplanted maize could be grown at lower N rates to achieve similar yield potentials as direct-seeded maize, and that transplanting can help to improve crop stands in areas where bird damage on emerging seedlings is a problem.

*Comparative performance of directly seeded and transplanted green maize under farmer management in Zanyokwe:* Transplanting was shown to be an effective way of increasing maize crop stands in a previous study. However, the economics of maize transplanting remained unclear especially in smallholder irrigation schemes where labour availability can be a challenge. This participatory on-farm experiment was conducted on six farms to evaluate comparative performance of direct-seeded and transplanted green maize under farmer management, and to work out the economics of transplanting. The results of this study suggest that transplanting can help in achieving a good plant stand which would translate to more green cobs and higher returns in areas where bird damage is a problem. Despite the popularity of transplanting during the execution of the trials, subsequent evaluation indicated that only one farmer adopted the technology the following season, meaning that the technology might not be suitable in situation where labour is in short supply as was the case of the study area. In this case, transplanting is unlikely to succeed unless the labour intensiveness of manual transplanting can be solved. In spite of this, the overall number of green maize producers in the scheme increased, indicating that farmers are more comfortable with direct-seeded green maize production. The findings of the study suggest that use of transplants can result in more timely

operations, improved water use efficiency and higher cropping intensities. Since transplanted maize produced longer cobs than direct-seeded maize at the same N rate, this means that it might be a better alternative for smallholder farmers who generally apply low fertiliser rates

### to their maize. **Technological options for addressing agronomic constraints at TFIS**

Field testing research activities at Tugela Ferry focussed on the development of a market-linked crop production plan. The main focus of the agronomic work was on building up data on agronomic management practices for crops selected to be part of the crop production plan for Tugela Ferry. The crops studied were cabbage, onion, potato, maize and butternut. The findings of the agronomic studies conducted are summarized below: *Yield determination for cabbage and onion in field trials at Tugela Ferry:* The objective of the cabbage study was to determine the effect of cabbage planting density on crop performance during growth and on the final yield. Results obtained showed that above average cabbage yields could be realized at Tugela Ferry with the adoption of the recommended cabbage planting density of 40 000 to 45 000 plants ha<sup>-1</sup>. Planting densities that were significantly higher than those recommended for cabbage in South Africa, caused yield reductions even under high levels of management. The objective of the onion trial was to determine the optimum seeding rate, transplant size and planting density for onion production at Tugela Ferry. Results obtained clearly showed that the optimum seedling size for onion crop establishment is 20 cm (three leaves). Small seedlings (8 cm) performed poorly possibly due to their relatively smaller photosynthetic area compared to that of the larger seedlings. Therefore, onions need to be established using large seedlings (having three leaves or 20 cm in length). Small seedlings are to be avoided as they take longer to establish and may contribute to a large number of culls (non-marketable bulbs) due to small size. These results clearly demonstrated the importance of planting density and seedling size for production of cabbage and onion, respectively. The cabbage and onion trials were also designed to enable comparisons between experimental trials (managed by master farmers) and farmer-managed crops. The experimental trials indicated what could be considered as the potential crop yield of the studied crops while farmer-managed trials showed what could be considered as the average crop yield. The results indicated that crops grown in master farmer-managed experimental trials performed at a higher level than those grown by regular farmers at Tugela Ferry who were not directly involved in the researcher trials. This is a remarkable result as it indicated the ability of farmers to learn and adopt improved crop husbandry practices.

*Effect of potato propagule size on yield:* The experiment was designed to address farmers' concerns about the possible effect of planting material on crop performance after they observed great variability in seed potato size from the same source. The treatments consisted of two cultivars, BP1 and Up-to-date, and two average seed sizes 120 g per propagule (range = 95 to 133 g) and 25 g per propagule (range = 17 to 32 g). The results showed that for both cultivars, larger propagules produced higher stand establishment, with plants displaying greater vigour than those produced with small propagules. The yield data obtained suggested that seed potato size influenced yield through its effect on plant vigour and tuber setting. *Maize and butternut response to water conservation:* The objective of this study was to determine the effect of mulch on maize and butternut squash production in Tugela Ferry. The results obtained showed that mulching improved plant growth and minimised moisture loss. The presence of mulch and weeding, separately, caused significantly better plant growth than no mulch and no weeding. The application of mulch improved maize cob size for two cultivars (SR 52 and SC 701) studied, and weed cultivation minimized the decrease in cob quality caused by weeds, even in the absence of mulch. Furthermore weed removal improved grain size for both cultivars but the amount of water in the grain was higher in the presence of mulch compared with the absence of mulch. Generally mulch application improved prolificacy and yield of both maize and butternut. Cultivar SR 52 had a larger grain size than SC 701, but the latter had longer cobs with more rows per cob compared with SR 52. Generally, crop yields attained for potatoes and butternut squash at Tugela Ferry were within the range expected for these crops in South Africa. However, improved access to irrigation and crop protection could increase the yields further by eliminating crop losses. Hence, training of farmers on cultural practices to minimise stresses from diseases and pests, may contribute to increased yield with minimum water.

### **ACCESS TO EXTENSION SERVICES**

Availability of competent extension service support is critical to the success of farming enterprises, including irrigated farming systems. The provision of this service is usually the mandate of the departments of agriculture in the provinces. Observations at the two schemes showed that the departments of agriculture in the two provinces were providing the service but not at optimal levels. The reasons for less than optimal extension services varied between ZIS and TFIS. Farmers at ZIS no longer have their own extension officers, unlike when the project started, because the department of agriculture introduced the ward system, whereby ZIS together with a number of other villages form

ward 10 serviced by two extension officers. In addition, lack of transport for extension officers continued to prevent extension officers from interacting more often with farmers. Access to extension services is much better in Tugela Ferry because the district office of the Department of Agriculture and Environmental Affairs (DEAE) is located just about 5 km from the scheme and it had four technicians dedicated to the scheme. The impact of extension services on farming operations at both schemes was also limited by the fact that extension officers lacked basic technical skills on crop husbandry and irrigation management. This lack of skills was worse in terms of irrigation management as none of the extension officers at the two schemes had any formal training in irrigation management, and did not consider its transmission to farmers to be part of their mandate. Capacity building is, therefore, required in crop husbandry, water management and other areas of operation and maintenance of irrigation to enable extension officers to provide meaningful support to farmers.

### **GENERAL PROJECT IMPACT**

The project had a positive impact on the irrigating and non-irrigating communities of Zanyokwe and Tugela Ferry. The participatory implementation of interventions to address identified constraints related to institutional arrangements, socio-economic factors, water and crop management factors were to a large extent successful. This was reflected by improvements in: (i) land use intensity, (ii) crop husbandry practices such as timely planting, weeding, fertilizer application, choice of crop cultivars, (iii) ability of some farmers to plan and execute crop trials from which lessons were learnt, (iv) household incomes, (v) household food security (vi) marketing knowledge and strategies (vii) capacity of farmers and extension officers to identify problems and solutions, (viii) record keeping by farmers and (ix) farmer institutional and organisational arrangements.

### **GENERAL RECOMMENDATIONS**

Of the four constraints summarised above, weak institutional and organisational arrangements and poor crop management practices contributed the most to the underperformance of the two schemes. Weak institutional/organisational arrangements and lack of strong decisive leadership impacted negatively on every aspect of the irrigated cropping systems while poor crop husbandry practices such as weed, fertiliser and water management, late planting, low plant populations, cultivar choice and low cropping intensities contributed to the low productivity levels observed in the schemes. The findings of the action research agronomic studies clearly indicated that it is possible to achieve potential or near-potential yields such as attained in commercial farms by simply improving the crop husbandry practices. It is, therefore, recommended that smallholder irrigation scheme revitalisation programs should place (i) capacity building in basic crop and irrigation management practices, and (ii) strengthening institutional/organizational arrangements prominently in their revitalisation agendas in any efforts to improve on the performance of these schemes in South Africa. Other specific recommendations are:

1. The farmer organisational and management structures that were put in place at the two schemes should be strengthened and sustained so as to ensure that the schemes are properly managed and administered.
2. The process of forming Water Users Associations started at the schemes during the lifespan of the project should be finalised. The new farmer management structures at the schemes need to cooperate with DWA and the Provincial Departments of Agriculture to finalise this exercise.
3. There are many well meaning organisations that get involved in the schemes on different occasions, but whose activities are not coordinated and sometimes end up being counterproductive. This could be addressed through the establishment of stakeholder committees at the schemes which would ensure that the synergies of all organisations active in the schemes are optimally exploited for increased productivity at the schemes. This task could ideally be spearheaded by the Provincial Department of Agriculture in each province as it is the most active organisation in each scheme.
4. Land tenure policies that would allow increase of access to arable land to those interested and capable of farming in the schemes must be urgently developed. This will increase land utilisation and improve productivity and overall scheme performance. The urgency for action in this regard is greater for ZIS than it is for TFIS.
5. Revitalisation programs should not focus on hardware issues only but rather on all constraining factors including the soft aspects such as capacitating farmers in basic crop husbandry and irrigation management skills.
6. Farmers at both schemes need to receive regular training in basic crop husbandry, irrigation management, record keeping, financial management, and leadership skills. Empowering the farmers with non-farming skills will empower them to be good managers for their farming activities, the people they work with as well as those who work for them.
7. Poor maintenance of irrigation infrastructure at both schemes seems to be a result of the fact that

farmers do not view the scheme infrastructure as their property. To ensure that ownership is entrenched in the minds of the irrigators, all revitalization and development initiatives at the schemes should involve the irrigators in a participatory way at all stages of the processes.

8. Access to support services such as credit, market information and intelligence, extension services should be strengthened. It is recommended that the departments of agriculture assign and train extension officers dedicated to servicing the irrigation schemes.

9. Crop planning in the schemes should be market driven as informed by market information and intelligence.

10. Both schemes need to explore alternative cropping systems that would ensure viability in the face of limitations of labour and skills. One labour-saving technology that warrants investigation is the practice of conservation agriculture. Adoption of conservation farming practices would (1) reduce labour requirements especially in peak operations of land preparation and weeding, (2) increase food security by making more efficient use of irrigation water, and by increasing soil fertility through the introduction of N-fixing cover crops, and (3) improve pest regulation and reduce dependence on external inputs.

11. Levels of productivity were much higher in TFIS than ZIS. There are, therefore, lessons that farmers in ZIS can learn from those in Tugela Ferry. Exchange visits organized for the two schemes could help irrigators at the schemes to learn from each other.

12. Academic institution partnerships can play important roles in the generation of knowledge, testing of technologies and adoption of the same by farmers on the schemes. It is recommended that such partnerships be institutionalised through the establishment of research chairs on irrigated cropping systems at selected key institutions located in areas where there are many irrigation schemes in the vicinity of the institutions. This could be implemented on a pilot basis to begin with.