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Review

Revitalisation of smallholder irrigation schemes for poverty alleviation and household food security in South Africa: A review

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There seems to be a general consensus that improving agriculture and enhancing agricultural productivity through irrigation will remain a key strategy for rural poverty alleviation in most of the low income countries, where the majority of the rural poor depend directly or indirectly on agriculture. Nevertheless, Smallholder Irrigation Schemes (SIS) in South Africa have performed poorly and have not delivered on their development objectives of improving rural livelihoods through sustainable crop production for food security and poverty alleviation. For a long time, dilapidated irrigation infrastructure was viewed as the single major cause of the poor performance and the government invested huge sums of money towards repairing infrastructure. Consequently, research and expenditure tended to focus on irrigation infrastructure, but often this proved fruitless because the human capital was not developed to effectively utilise and maintain the infrastructure. Recent research, however, has identified weak institutional and organisational arrangements and poor technical skills of farmers as probably the major factors leading to underperformance of most SIS. It is therefore recommended that crop production approaches including farmer training be considered alongside all other issues during revitalisation of SIS to improve on performance.

Key words: Farmer management skills, food security, institutional and organisational arrangements, poverty alleviation, revitalisation, smallholder irrigation schemes.

INTRODUCTION

South Africa receives about half of the average global annual rainfall and is the 30th driest country in the world in terms of available water per capita (Schreiner et al., 2010). Over 60% of the country receives less than 500 mm of rainfall per annum, which is theoretically the minimum required for successful dryland cropping, while 21% receives less than 200 mm (De Villiers et al., 2004). Only 7% of the total area of the country receives more than 800 mm per annum (Schulze, 1997). Irrigated agriculture accounts for almost 30% of total crop production and is the single largest user of water in the country. South Africa is a water-scarce country, and, although water consumption through irrigation has decreased from 80 to about 50% over the past 25 years, the need to improve water use efficiency in irrigation farming is more imperative than ever (De Villiers et al., 2004). Given the scenario of water scarcity in the country, increasing water productivity in agriculture is indispensable. The more we produce with the same amount of water, the less the need for infrastructure development, the less the competition for water, the greater the local food security, and the more water for agriculture, household and industrial uses and the more that remains in nature (Hamdy et al., 2003). To achieve 'more crop per drop', either production must be increased, keeping water constant, or the same amount of production must be maintained while using less water. Changed crop varieties, crop substitution, precision irrigation and improved water management are some of the strategies that can be used to increase water productivity (Hamdy et al., 2003). The South African context of a highly unequal society with high levels of poverty (Seekings, 2007) requires that water resources management should have a consciously pro-poor focus (Schreiner et al., 2010). There seems to be a general consensus that improving agriculture and enhancing agricultural productivity will remain a key strategy for rural poverty alleviation in most of the low income countries, where the majority of the rural poor depend directly or indirectly on agriculture (Hussain and Hanjra, 2004). Although water provides only a single element in the poverty equation, it plays a disproportionately powerful role through its impact on such factors as food production (Hussain et al., 2004).

Access to reliable irrigation can enable farmers to adopt new technologies, leading to increased productivity, overall higher productivity and greater returns from farming. This, in turn, opens up new opportunities, both on-farm and off-farm, and can improve income, livelihoods and the quality of life in rural areas (Hussain et al., 2004). Hussain et al. (2004) mention five key interrelated dimensions of the relationship between access to good agricultural water, socioeconomic uplifting in rural communities and poverty reduction. The dimensions are production, income/consumption, employment, vulnerability/food security and overall welfare (Figure 1). In general, access to good irrigation allows poor people to increase their production and income, and enhances opportunities to diversify their income base, reducing vulnerability caused by the seasonality of agricultural production as well as external shocks. Thus, access to good irrigation has the potential to contribute to poverty reduction and the movement of people from ill-being to well-being (Hussain et al., 2004). Increased output from irrigated agriculture may arise from improved yields, reduced crop loss, improved cropping intensity and increased cultivated area (Namara et al., 2010). Accordingly, reliable access to water enhances the use of complementary inputs such as high-yielding cultivars and agrochemicals which also increase output levels, improve farm income and reduce poverty (Smith, 2004).

SMALLHOLDER IRRIGATION IN SOUTH AFRICA

South Africa has about 1.3 million ha of land under irrigation; of which about 0.1 million hectares is in the hands of smallholder farmers (Backeberg, 2006; Van Averbeke, 2008). In order to describe the smallholder irrigation sector, one needs to have a good understanding of who the smallholder farmer is. Terms used to describe smallholder farmers include small-scale farmers, resource-poor farmers, peasant farmers, food-deficit farmers, household food security farmers, land-reform beneficiaries and emerging farmers (Machethe et al., 2004). The main criteria often used to classify farmers as smallholders by various analysts include land size, purpose of production (subsistence or commercial), income level (whether poor or rich), and, in South Africa, racial group. Various definitions have been used to describe smallholder farmers in South Africa (Machethe et al., 2004; Botha and Treurnich, 1997; Catling and Saaiman, 1996; Van Zyl et al., 1991; Eicher, 1990). In the South African context, smallholder farmers are defined as black farmers most of whom reside in the former homelands. It is also noted that not every black farmer is a smallholder farmer and smallholder farmers are not a homogenous group (Machethe et al., 2004). Smallholder irrigators in South Africa have been categorised into four groups namely farmers on irrigation schemes, independent irrigation farmers, community gardeners and home gardeners (Crosby et al., 2000; Du Plessis et al., 2002; Van Averbeke, 2008). According to Backeberg (2006), there are 200 000 to 250 000 smallholder irrigators contained in these four groups.

This review is concerned with one group of smallholder irrigators, namely those operating on irrigation schemes.

Smallholder irrigation schemes in South Africa

South African SIS can be defined as multi-farmer irrigation projects larger than 5 ha in size that were established in the former homelands or in the resource poor areas by black people or agencies assisting their development (Van Averbeke, 2008). These schemes are under local responsibility, controlled and operated by the local people in response to their felt needs, and using a level of technology which they can operate and maintain effectively (Underhill, 1984). Such schemes vary in size, both in terms of the number of farmers supported by a particular scheme and the size of the scheme. Over the years, many SIS have been established in South Africa in order to gain accessibility to productive land and increase production in the different regions of the country. Available evidence indicates that in 2010 there were 302 SIS in South Africa, with a command area of 47 667 ha (Van Averbeke et al., 2011). Not all 302 SIS were operational in 2010 and not all operational schemes were fully functional (Van Averbeke et al., 2011). Most of the schemes have collapsed or are utilised well below their potential. About 79% of the SIS are located in the Eastern Cape, KwaZulu-Natal and Northern Provinces. The primary goal of establishing these schemes was to improve rural livelihoods through sustainable crop production for food security and poverty alleviation (FAO, 2001). However, because of poor performance, the development objectives of SIS remain largely unfulfilled (Yokwe, 2009; Fanadzo et al., 2010a, b). As such, the benefits of irrigation have not been realised in the smallholder sector of South Africa.

The inability of these schemes to bring about the expected social and economic development has raised doubts about irrigation being a suitable option for rural development in former homelands. This is in contrast to

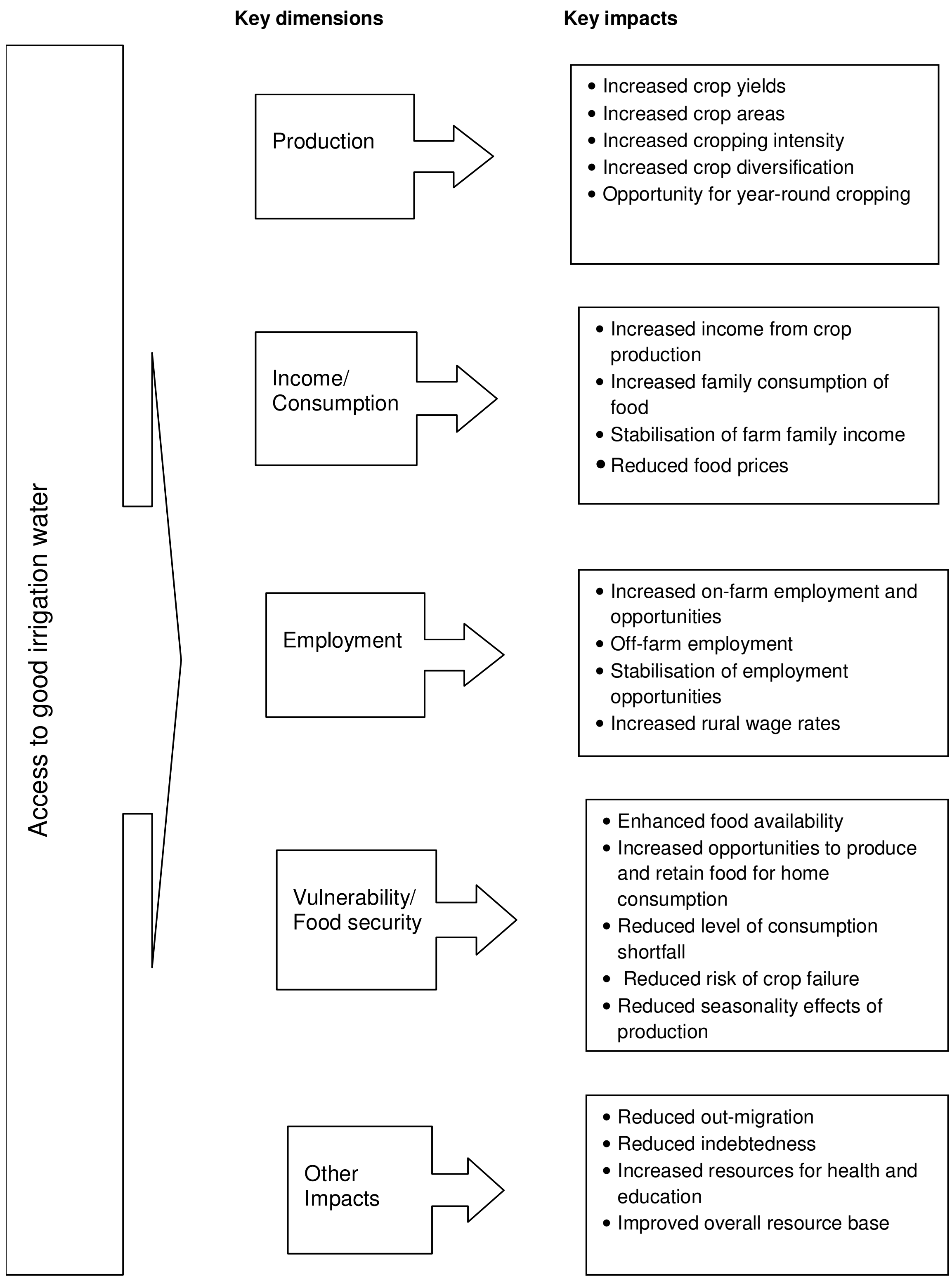

Figure 1. Agricultural water and poverty reduction: Key dimensions (Source: Hussain et al., 2004).

the international scene where irrigated agriculture is still recommended as an appropriate way of addressing rural poverty and enhancing food security in areas where sustained rainfed production of crops is limited by water deficits (Hussain and Hanjra, 2004; Namara et al., 2010; García-Bolaños et al., 2011). The current era in South African smallholder irrigation development can be referred to as the irrigation management transfer (IMT) and revitalisation era. IMT refers to the transfer of the responsibility of managing, operating and maintaining irrigation schemes from the government to the farmers (Van Averbeke, 2008). The process of IMT includes government withdrawal, formation of water users associations, development of local management institutions, and transfer of ownership and management to farmers (Perret, 2002). Since the late 1990s, the South African government has implemented a nationwide program to revitalise state-owned SIS. The drastic withdrawal of pre-1994 support to SIS by the Department of Agriculture led to widespread partial or full collapse of these irrigation schemes, most of which are located in the former homelands. The revitalisation of these schemes appears highly problematic (Schreiner et al., 2010).

CAUSES OF POOR PERFORMANCE OF SIS IN SOUTH AFRICA

The causes of poor performance of SIS in terms of productivity and economic impact are varied and include socio-economic, institutional, technical, political, climatic and design factors, as well as lack of farmer participation (Bembridge, 2000; Denison and Manona, 2007a). For a long time, dilapidated irrigation infrastructure was viewed as the single major cause of poor performance and the government invested huge sums of money towards repairing irrigation infrastructure. In this respect, De Lange et al. (2000) noted that research and expenditure tended to focus on infrastructure, and that often this proved to be fruitless because the human capital was not developed to effectively utilize and maintain the infrastructure. However, recent research has indicated low yield levels caused by poor crop and water management practices by the farmers as probably the main reason for the failure of many SIS in South Africa (Crosby et al., 2000; Fanadzo et al., 2010a, b). At the same time, limited knowledge of crop production among farmers has been identified as one constraint to improved crop productivity in SIS (Machethe et al., 2004). Among the primary constraints identified by extension officers on 164 of the 302 irrigation schemes, poor management topped the list (50% of cases); followed by infrastructural problems (15%); water inadequacies (13%); conflict (12%) and theft (7%) (Van Averbeke et al., 2011). This suggest that human (capacity) and social (institutional) resource problems were at the heart of the poor performance of SIS in South Africa identified by nearly all assessments that were made (Van Averbeke et al., 2011). In this regard, Denison and Manona (2007a) recommended that crop production approaches including farmer training be considered alongside all other issues during revitalisation of SIS to improve on performance.

In the former homelands, where the majority of SIS are situated, a number of SIS were planned and established following a centralised estate design whereby control over farming activities and decision making was strictly enforced by central management with little or no input from farmers. This created a high level of dependency among farmers in the schemes and poor performance when farmers were left to manage the schemes on their own. Experience elsewhere in sub-Saharan Africa has shown that SIS can succeed if farmers participate in design and management (FAO, 2000). As a result of these positive African experiences, the South African government policy has gradually moved towards entrusting more responsibilities to smallholder farmers to manage SIS.

Case study 1: Zanyokwe irrigation scheme

Zanyokwe irrigation scheme, established in 1984 is one of the six major SIS in the Eastern Cape Province of South Africa that was planned and established following a centralised estate design. Zanyokwe uses sprinkler irrigation with a command area of about 635 ha, but the area irrigated ranges from 412 to 534 ha (Neven et al., 2005; Tlou et al., 2006), while plot size ranges from 1 to 12 ha. Challenges cited in literature for poor performance of Zanyokwe include complicated land tenure, poor maintenance of infrastructure and equipment, lack of farmer training, local and political conflict, high pumping and maintenance costs, lack of credit and poor market opportunities (Mnkeni et al., 2010). The ranking of these challenges varies depending on the literature consulted (Bembridge 2000; Tlou et al., 2006; Stevens, 2007). Mnkeni et al. (2010) summarized the constraints faced by farmers at Zanyokwe as shown in Figure 2. In a recent study, Fanadzo et al. (2010a) attributed the poor performance of Zanyokwe to inadequate water management that limited crop productivity, low cropping intensities averaging 48% and low yields of main crops. For instance, the yields of main summer crops, maize (*Zea mays*) and butternut (*Cucurbita moschata*) were 20 to 30% of the potential for the cultivars used. Other main constraints to crop productivity were poor management of basic practices such as weed, fertilizer and water management as well as late planting, low plant populations and use of inappropriate varieties. For example, inadequate weed management resulted in a 100% yield reduction in some cases where farmers abandoned crops to weeds due to shortage of labour for weeding. Not only did the farmers apply very low rates of fertilisers, but also in many cases, the timing of application was incorrect (Fanadzo et al., 2010a). For instance, while butternut growers applied a fifth of the total nitrogen at planting, the recommendation is to apply half to two thirds of the entire nitrogen at planting and the

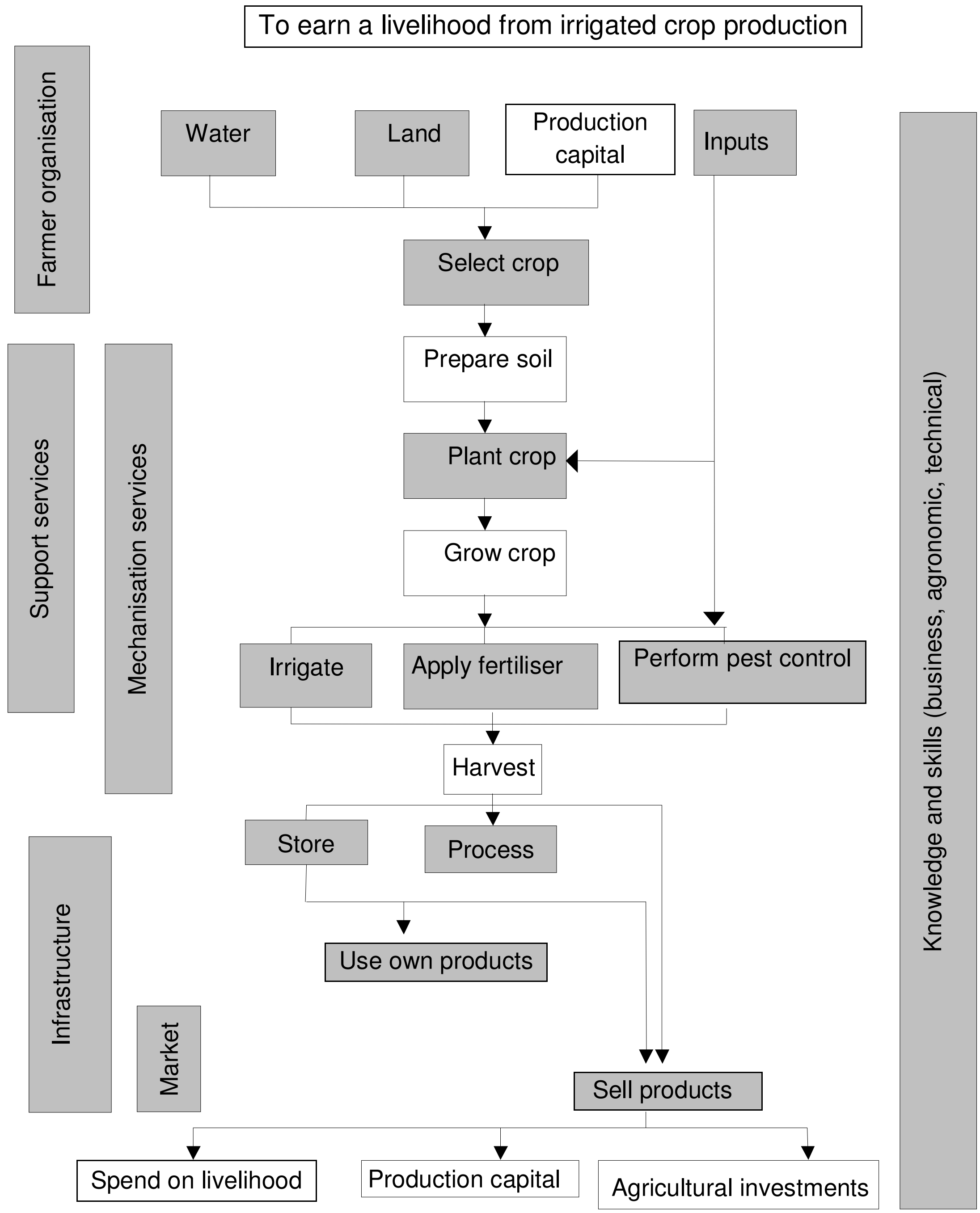

Figure 2. Areas of constraint (shaded) at Zanyokwe Irrigation Scheme (Mnkeni et al., 2010).

remainder as topdressing (Boyhan et al., 1999; National Department of Agriculture, 2005).

A yield gap analysis of the major crop enterprises at Zanyokwe showed that large yield gaps exist between yields achieved by farmers and yields attainable with good management. The yields achieved by farmers were a small fraction of the economic yields as tested in on-farm researcher-managed trials conducted in the scheme during the same period (Fanadzo, 2010). The fact that the yield from on-farm trials were not very far from the commercial yields despite the state of the irrigation infrastructure at Zanyokwe means that, although access to reliable water is essential, it is not a sufficient condition for sustainable improvement in crop productivity at the scheme. Factors responsible for such large yield gaps (yield constraints) were identified as being mainly the

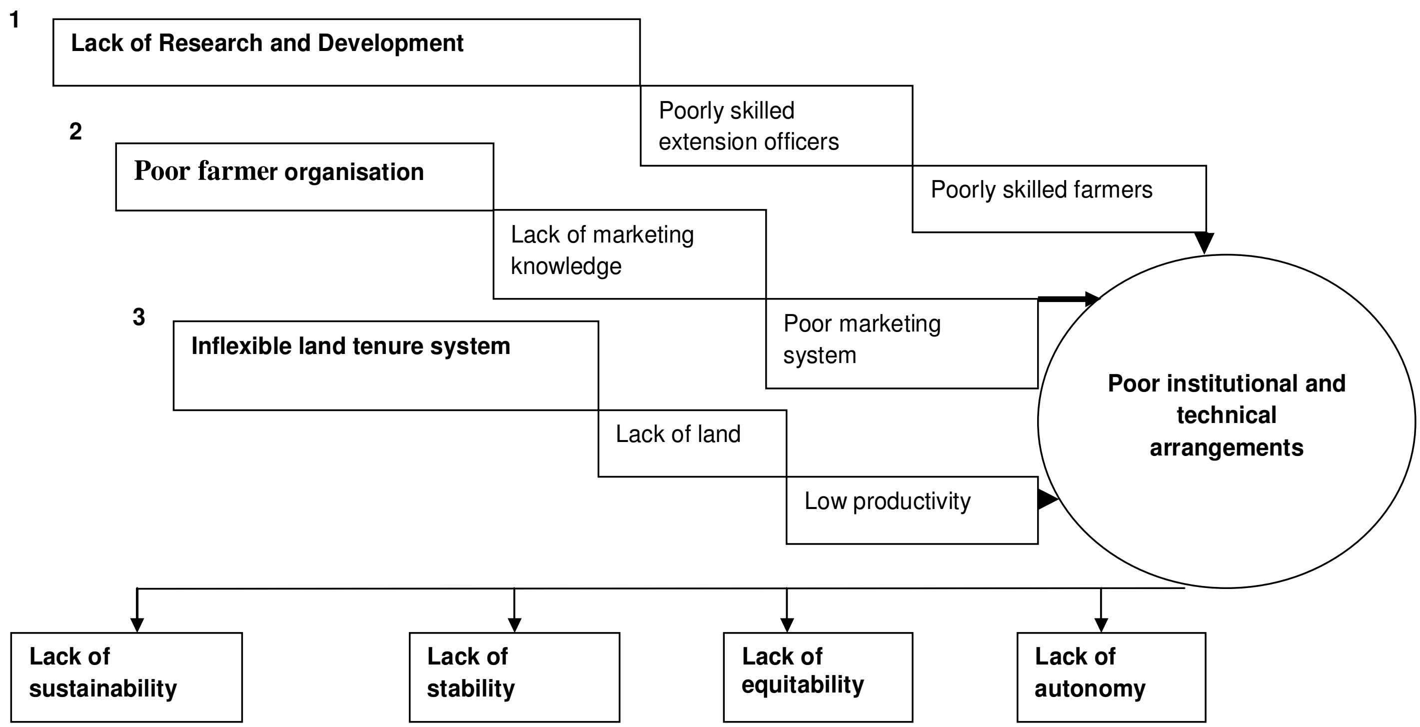

Figure 3. Three cascades (1, 2 and 3) representing nine key issues leading to institutional and technical constraints to best agroecosystem management at Tugela Ferry irrigation scheme (Mnkeni et al., 2010).

regard, it is expected that farmers could benefit from 'back to basics' training programs in the areas of crop and irrigation water management. The revitalisation efforts in Zanyokwe to date have not paid full attention to all major challenges cited in previous studies, for example land tenure (Tlou et al., 2006; Mnkeni et al., 2010). The focus has mainly been on hardware (irrigation infrastructure) issues, raising questions of the effectiveness and sustainability of investment made in the scheme.

Case study 2: Tugela ferry irrigation scheme

The Tugela Ferry Irrigation Scheme is located in the Msinga District in KwaZulu-Natal Province on both banks of the Tugela River. The scheme was originally planned by the then Department of Bantu Administration and Development, and was operational before 1932 (Mnkeni et al., 2010). The scheme consists of seven blocks of irrigable land covering about 840 ha of which approximately 540 ha is flood-irrigated. A situation analysis conducted at the scheme in 2004 unearthed some of the major productivity challenges (Mnkeni et al., 2010). Using a constraint analysis, nine issues, falling within the institutional and technical issues constraining best management of the scheme as an agroecosystem were identified as shown in Figure 3. The consequence of poor institutional and technical system was a compromise or loss of key agroecosystem attributes of sustainability, stability, equitability and autonomy (Figure 3). Table 1 presents a summary of the constraints found at the two case study irrigation schemes organised according to system components. The analysis of the constraints at the two schemes shows the same trend; farmers experience constraints mostly with regard to the external components of resources, the operational environment and management practices.

FROM REHABILITATION TO REVITALISATION

In South Africa, research seems to justify further investment in existing schemes rather than in the construction of new schemes. On this issue, Denison and Monona (2007b) argue for broad-based strategies, driven by market, land and management thinking, and states that priority must be given to improved utilisation of existing schemes. The distinction in the terms "rehabilitation" and "revitalisation" is directly linked to the investment into existing schemes, and the terms differentiate between an engineering-centred approach and a people/systems/market centred approach (Denison and Manona, 2007b). Rehabilitation is the more engineering-centred reconstruction of dilapidated infrastructure (hardware components) and is focused

Table 1. Summary of constraints at Zanyokwe and Tugela Ferry irrigation schemes.

	Tugela Ferry	Zanyokwe
Resources		
Water	Main canal infrastructure (broken sluices and leaking night dams); main canal management (operation and maintenance); pumped water costs and pump maintenance.	Main pipeline and equipment in need of repairs; lack of skilled water management staff for trouble shooting at village level; regular maintenance needed.
Land	Plot sizes and locations limit optimum production; land tenure limits commercialisation potential; fields need to be well fenced; soil quality needs to be managed better.	Complicated land tenure system; unequal land sizes; water logging and bush encroachment in places.
Production capital	Poor budgeting skills; low profitability.	Lack of funds lead to low cropping intensities and productivity; farmers want more access to credit yet loan repayment is mentioned as a problem.
Inputs	Access to inputs; unsuitable type or amount of inputs bought by farmers; farmers not organised to bargain; co-operative not functioning.	Pesticides and fertiliser is not readily available and expensive; too little fertiliser results in low yields.
Operational environment		
Farmer organisation	Poor collaboration between farmers; little sharing of knowledge between farmers; youth not involved at scheme; crop selection not planned; pack-house built but not used.	Different organisations; irregular meetings; lack of trust amongst farmers; poor project introduction and therefore farmer support.
Support services	Poor relationship between farmers and extension service; little involvement of extension officers with local research; lack of practical skills and know-how of extension officers; farmers' reluctance to implement advice given to them due to lack of understanding and trust.	Poor extension service, mainly due to lack of transport.
Infrastructure	-	Poor road serving the scheme; lack of transport.
Mechanisation services	Lack of implements and a tractor at the scheme.	Affordability of tractor services; lack of draught animals.
Markets	Market flooded with similar products at once resulting in low prices.	Poorly organised; middlemen cheat farmers; lack of contracts and standardising of prices.
Tasks		
Crop selection	Little variation in crops; variation limited by lack of land.	Farmers would like to grow alternative crops but is hindered when specialist implements are needed.
Planting	-	Late planting due to lack of mechanisation services; no planting programme.
Irrigation	Availability of water in-field during peak periods; lack of scheduling knowledge.	Leakages in underground pipes; worn and inadequate in-field equipment; lack of pressure; lack of scheduling knowledge.
Selling produce	Low productivity; local market insufficient; poor recordkeeping.	Low productivity; poor access due to transport problems; produce spoils due to poor road condition.

Table 1. count'd.

Management		
Knowledge and skills	Productivity levels limited by poor crop and irrigation scheduling; incorrect inputs obtained and applied; poor marketing skills; lack of training opportunities; literacy of farmers.	Farmers need to be more involved with scheme management; conservation farming practices; business skills are needed to protect the farmers from exploitation.

Source: Van der Stoep (2006).

primarily on securing the water supply and repairing the irrigation distribution system. Rehabilitation interventions tend to have minimal engagement with the organisational dynamics of water apportionment, the agricultural poor management of basic practices by farmers. In this production system, farmer learning processes, financing and market (Denison and Manona, 2007b). Revitalisation of irrigation schemes, on the other hand, is a global trend that is rooted in a holistic development philosophy that is argued to result in more successful outcomes than simply repairing infrastructure. The concept of revitalisation is broad in its development focus and carries with it the expectation of re-building socially uplifting, profitable agri-business on existing schemes and in the communities surrounding schemes. Human capital development both individually and organisationally, empowerment, access to information, marketing and business strategy development are emphasised alongside repair and re-design of existing infrastructure (Denison and Manona, 2007b).

A study of Zayokwe irrigation scheme indicated that the issues that prevent optimization in spite of all other existing constraints are matters that farmers take for granted and that do not appear in any of their priority constraints; their current management of farming enterprises (Fanadzo, 2010). The study demonstrated that whilst crop productivity by farmers continues to be low, it could be higher even with current status of irrigation infrastructure. For instance, the marketing problem cited by farmers during a situation analysis conducted at the scheme was a consequence of their failure to meet the quality and quantity requirements for specific markets. The findings by Fanadzo (2010) point to the need for balancing soft (institutional, organisational and technical) and hard (infrastructure) components of the irrigation system in order to attain sustainability. Single sector interventions such as repairing infrastructure only or supplying tractors alone are highly unlikely to succeed or achieve positive results. In order to improve livelihoods, smallholder farmers need support systems that include training in agronomic management of crops. In this respect, the South African experience shows clearly that budget allocations for training, management and institutional development need to be 40 to 50% of the total intervention budget (Denison and Manona, 2007a), and yet the core focus of the provincial departments of Agriculture has largely been on rehabilitation. In Nepal, Neeraj et al. (1998) noted that projects that have paid equal attention to infrastructure (hard components) as well as the social and institutional systems (soft components) of water user organisation and agricultural production are excellent models of intervention with higher success rates.

The core focus of provincial departments of agriculture on rehabilitation alone raises the issue of sustainability of SIS in South Africa. This is supported by Denison and Manona (2007a) who wrote:

"Experience is clear that infrastructure development alone as a dominant part of the intervention (revitalisation) is highly unlikely to succeed. Farmers in smallholder schemes need support that go far beyond just the irrigation system if they are to improve their livelihood significantly. Narrow sectorally isolated engineering and infrastructure driven programs have substantially increased risk of failure. The interventions that are based on comprehensive strategies addressing the complex of activities that make up the irrigation enterprise are most likely to succeed. These include markets, finance, inputs, infrastructure, institution building and crop production information."

As Abdullah (2006) puts it, the irrigation engineer has traditionally depended mainly on engineering measures to meet water savings targets. He asserts that the future will require modernisation of irrigation and drainage, which means not only modernising the infrastructure, but includes improving the management of the scheme as well as bringing in institutional reforms. Revitalisation efforts in South Africa should be aligned with insights by Abdullah (2006) who defined irrigation modernisation as "a process of technical and managerial upgrading of an irrigation scheme combined with institutional reforms with the objective to improve resource utilisation and water productivity." Abdullah (2006) argues that in terms of infrastructure and technical aspects, modernisation (or revitalisation) is relatively straight forward. The bigger challenge is in the "software" and "humanware" components. Irrigation service providers have to be more client-focused and customer-oriented, and include wider stakeholders' participation with the empowerment of water user organisations such as farmers' associations and their involvement through participatory irrigation management (Abdullah, 2006). As already mentioned, although access to reliable water is essential, it is not a sufficient condition for sustainable improvement of the performance of SIS in South Africa. Thus, whilst productive use depends on irrigation technology, it will only be successful when information supply to farmers is made a core priority in the overall intervention design.

Improving institutional arrangements, organisational set-up and capacity building of farmers and irrigation agencies are some additional measures that could help improve water management (Birendra et al., 2011). Areas of focus in revitalisation should include technical support in the form of training farmers and extension officers, ensuring sustainable cropping systems, and institutional and organisational strengthening. These issues are briefly discussed as follows:

The need to strengthen extension and farmer training

Whilst research has a role to play, the study by Fanadzo (2010) demonstrated the importance of investing in extension. The study indicated that extension officers lacked skills, particularly in irrigation water management. Indeed, farmers were of the opinion that the extension services had declined in terms of both contact time and technical knowledge. Given the potential contribution of smallholder irrigation to food security and farmer livelihood in rural areas where most SIS are located, it is recommended that the Department of Agriculture assign and train officers dedicated to servicing SIS. These should be based at schemes and should show good practice of water management, operation and maintenance of schemes and demonstrate good agronomic management in support of farmers. According to Machethe (2004), access to agricultural support services remains a major factor constraining the growth of smallholder agriculture in the former homelands. The study by Fanadzo et al. (2010a) indicated a general lack of production skills among farmers and farmer training is expected to improve on productivity through capacity building. Van Aberbeke et al. (2011) concurred that on most SIS, farmers have not reached the necessary level of competency and confidence to optimally exploit their farms. The impact of farmer training has been demonstrated in many countries where productivity and income levels increased as a result of higher yields. In Nigeria for instance, farmers doubled their productivity of rice and increased their net incomes by 230% due to higher yields, both quantity and quality after receiving basic training on crop production (List, 2009). After being offered training on proper management of potatoes including correct timing and techniques of irrigation, fertiliser application and pest control, farmers in Afghanistan realised potato yield increases of 205% and their net incomes rose by about US$ 3000 ha^{-1} (Padma, 2009).

Botha and De Lange (2005) argue that smallholder farmers in South Africa have limited training and that formally available training is focused exclusively on scaled-down versions of the high cost and high-risk commercial production practices which are inappropriate to food insecure households. In addition, in the traditional research-extension linkage system, technology development and transfer have tended to be largely based on a vertical one-way communication with information flowing from research to extension and the role of extension is to transfer the information to the farmers. However, this approach has been shown to be inadequate because farmers are generally insufficiently involved in identifying problems, or in selecting, testing and evaluating the possible solution. In addition, research results have often not been delivered efficiently to extension workers who most of the time lack the necessary knowledge, skills and resources to motivate farmers to adopt such practices. The study by Mnkeni et al. (2010) used a participatory approach and this enabled the identification and testing of appropriate technologies with input from farmers. In terms of extension, one farmer participatory method that can be adopted is the farmer field school (FFS). FFS is based on the premise that the participating farmers become researchers who test various technological options available and the process enables them to decide on the better alternative for adoption in their particular circumstance (Asiabaka, 2002). In Kenya, the FFS approach was found to be more effective in knowledge acquisition, adoption and dissemination of crop management technologies among smallholder farmers than the conventional research-extension-farmer linkage (Bunyatta et al., 2006). The adoption of the FFS by the extension services in South Africa could improve on adoption and adaption of technologies, thereby improving performance of SIS.

Institutional and organisational strengthening

Farmers on irrigation schemes are dependent on each other because they share the water distribution system. This interdependence requires a willingness on the side of farmers to work collectively in order to achieve their individual objectives (Van Averbeke et al., 2011). Rules to govern collaboration (institutions) and structures to enforce these rules (organisations) are necessary for effective and sustainable functioning of collection action. Indications are that on their own, irrigator communities and their volunteer leadership structures, usually in the form of elected schemes committees, find it difficult to enforce rules (Van Avebeke et al., 2011). Farmers pursuing individual instead of collective goals challenge institutions and erode organisations of irrigator communities (Letsoalo and Van Avebeke, 2006; Orne-Gliemann, 2008). A study of two irrigation schemes, one in the Eastern Cape and the other in KwaZulu-Natal by Mnkeni et al. (2010) revealed that most of the problems in smallholder schemes were institutional and related to governance of the schemes. The study revealed that both schemes had very weak organisational and institutional arrangements. At both schemes, organisations were largely ineffective and did not ably discharge their responsibilities, which negatively affected productivity and overall performance of the schemes. Therefore, any revitalisation of such schemes would hinge first and foremost on the strengthening of farmer organisations. Many studies on SIS in South Africa have singled out land tenure as a major institutional challenge leading to poor performance (Tlou et al., 2006; Denison and Manona, 2007a, b; Mnkeni et al., 2010, Van Averbeke et al., 2011). Poorly-functioning land exchange markets, particularly for land rentals, appear to be one of the reasons why both dryland and irrigated land in African smallholder settings is not cropped more intensively (Bembridge, 2000; Tshuma, 2009). Inadequacies in tenure security, or at least the perceptions of such inadequacies among landholders and people seeking to lease land has been identified as one of the reasons for poor performance of many SIS in South Africa (Tlou et al., 2006; Denson and Manona, 2007a, b; Mnkeni et al., 2010). Farmers on quitrent (pay rent to magistrate) and right to occupy (communal under traditional leadership) land tenure arrangements have no sense of ownership and hardly invest in new technologies. Tlou et al. (2006) identified tenure as the system that had the greatest overall impact on other systems relevant to irrigation farming.

At one of the schemes, it was noted that some landowners noted successful production by farmers renting from them and cancelled leases. Worse still, some landlords did not feel secure enough to lease land in fear of losing it and preferred to take it out of production, resulting in large tracts of land lying fallow (Mnkeni et al., 2010). This created uncertainty as to future prospects of young farmers who would have committed resources to make a living from the practice of irrigation. Uncertainty in land tenure is a negative factor in fostering farmer investment in smallholder schemes in terms of infrastructure, skills and farmer organization. Insecure land tenure arrangements limit access to land and undermine interest and commitment to farming. From a legal perspective, tenure on irrigation schemes is ambiguous to say the least, because much of the legislation that applied when the plots were first allocated has since been revoked (Manona et al., 2010). Land tenure is certainly an important factor to consider in analysing issues of successful operation and maintenance of SIS. 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 hence scheme performance.

Sustainability of cropping systems

The cropping pattern generally used in SIS in South Africa is alternate summer and winter cropping for both field and vegetable crops. Maize is the most important summer crop in terms of the area devoted to the crop and number of growers (Perret et al., 2003; Machethe et al., 2004; Fanadzo et al., 2010a, b), while cabbage and/or wheat are the dominant winter crops, depending on province. The viability of most SIS based on the current cropping systems is open to question. Alternative cropping systems that would ensure viability in the face of limitations of labour and skills pose design challenges for researchers in SIS. Focus on labour-saving technologies should be a component of future research to address cropping systems in SIS. One labour-saving technology that warrants investigation is the practice of conservation agriculture. Adoption of conservation farming practices in SIS would potentially address three crucial areas of importance to the smallholder farmers: 1) reduction in labour requirements especially in peak operations of land preparation and weeding, 2) potential to 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) the possibility of reducing production costs for hand labour, hired labour, tractor hire and fertiliser use, and generating additional revenue through the production of fodder crops and cash cover crops. It is anticipated that the time saved can be used to expand on area cultivated, resulting in higher cropping intensities, or even start other enterprises that earn more money. Many studies on SIS in South Africa indicate that farmers tend to apply low fertiliser levels due to lack of cash to buy the input. Sustainable agricultural technologies such as substitutes for organic fertilisers need to be investigated. There is need to identify crops that are higher yielding, but less demanding with regard to nutrient requirements.

Identification of alternative crops that can be included in rotations to enhance soil fertility, weed management and give higher profits such as legumes should be explored. Adoption of conservation farming practices has the potential to lower risks and reduce cash flow requirements by cutting down on input costs.

Economic sustainability

Profitability is widely considered one of the critical factors for the success of SIS. An analysis of the national database of SIS in South Africa showed that commercialization (as opposed to subsistence farming) and the production of high-value crops (notably bulk and specialist vegetables) were common denominators in schemes which had high levels of activity and success (Denison and Manona, 2007b). Evidence points to the fact that the high productivity levels witnessed during the early stages of the establishment of most SIS, before irrigation management transfer were partly related to the production of high value crops. The shift in the current period to low-value crops such as grain maize-based cropping systems is not sustainable due to low profitability, especially amidst the rising cost of inputs such as fertiliser. For instance, the high cost of fertiliser and current low price of grain maize means that farmers will always operate at a loss, especially given that the yields achieved by farmers are generally low. Economic analysis using the mean yields for main crops achieved in three seasons of monitoring studies at Zanyokwe irrigation scheme indicated that it was not profitable to grow grain maize under irrigation (Fanadzo, 2010).

Partnership with agri-business

Tshuma (2009) noted that despite having a great sphere of influence, there was no physical structure or formal marketing system in place for farmers to sell their produce. Instead, farmers continued to rely on buyers or hawkers who came to buy produce from the field. One challenge facing high-value horticultural crop producers is the existence of a sophisticated logistical chain between the producer and the end consumer. This means that the producers have to be successful at both the sophisticated crop production process as well as at contracting with agribusiness that control the marketing of high value food chain (Cartwright, 2002). Backeberg (2006) shows this to be seriously challenging given South Africa's historical legacy which tends to exclude smallholder farmers from these networks and which is made more severe given a global market environment. This suggests the need for the development of a sustainable partnership between the farmers and agribusiness. Smallholders are motivated by the certainty of market access, reduction in price uncertainty, better access to inputs and reduced costs of inputs, and access to information and technology especially for new high value crops (Al-Hassan et al., 2006). On the other hand, the principal motivation of agribusiness is assured supplies of produce and regularity of supplies. Thus, smallholder and agribusiness linkages are vertical integrations aimed at meeting the constraints of either party, by providing market guarantees to the farmers and assuring supply to the purchases. The incentives brought about by better market access can result in expanded production and the accompanying adoption of productivity-enhancing technologies (Al-Hassan et al., 2006). It is for these reasons that the drive to improve market access is central in any efforts aimed at developing smallholder agriculture for poverty reduction. Linkage to agribusiness is even more desirable in cases where smallholders need to engage in the production of high value produce. This is because the production systems are more costly, the risks associated with them are higher than they are with traditional staple foods, and the information needs and skills requirements of high value crops are more demanding (Al-Hassan et al., 2006).

The World Bank has promoted contract farming as a way of creating dynamic partnerships between private capital and smallholders which would lead to technology transfer, innovation and market growth (World Bank, 2005). Literature on SIS in South Africa indicates that few exceptions to the general poor performance include the smallholder sugar cane farms in KwaZulu-Natal and Mpumalanga (Bembridge, 2000). The success of the smallholder sugar cane producers has been linked to partnership with agribusiness (Al-Hassan et al., 2006). The link of smallholders with the sugar company has improved livelihoods and alleviated poverty in many households in the communities, and the multiplier effects are visible as more small enterprises were established. Though some SIS farmers have been involved in contract farming in the past, there has not been any successful agribusiness-farmer linkage. The weakest point in the past contracts is that there has been no capacity building in terms of farmer training and monitoring in the crop production management, leading to poor quality and low quantity produce. Smallholders need markets, but they often need seasonal capital and inputs to enhance productivity. Enhanced capacity of smallholders to meet international standards is often the beginning of a fruitful engagement in profitable value chain systems (Al-Hassan et al., 2006). Farmer organisations are seen as an instrument for farmers to enhance their market power by providing training and extension, and facilitating acquisition of technology and other inputs. Such an organised body is expected to be a channel through which agribusiness might influence practices of individual members to achieve the quality requirements of the former.

This emphasises the need for institutional and organisational strengthening if smallholder farmers are to engage with the private sector successfully.

Agronomic and ecological sustainability

The lack of purposive crop rotations in most SIS renders the cropping systems unsustainable from an agronomic and ecological point of view. Crop rotation has been noted as the cornerstone of sustainable agriculture as it keeps soils healthy and crops at their peak nutritional value (Merfeld, 2009), thereby improving crop productivity. With properly designed rotations, each plant benefits from the crop that precedes it and helps the crop that follows it, through nitrogen fixation, breaking the life cycle of pests (weeds, insects and diseases) and improved microbial activity in nutrient cycling. Whilst a precise cropping system for perpetual use normally cannot be planned, a flexible plan that can incorporate different cropping systems is required. Of great importance are the economic and market considerations which determine the eventual viability of the cropping systems.

Synthesis

As Hussain et al. (2004) spelt out, the antipoverty impacts of irrigation can be enhanced by creating conducive conditions that could achieve functional inclusion of the poor. These conditions include equitable access to land, integrated water resources management, shift to high-value market-oriented production, opportunities for the sale of farm outputs at commensurate prices, but at low transaction costs, and opportunities for nonfarm employment. To the extent these conditions or enabling environments are lacking or imperfect, on-ground benefits of irrigation to the poor would continue to be discounted. For instance, in settings with high degree of inequality in land distribution, irrigation would have lower impacts on poverty, as water rights and potent benefits are virtually tied to ownership (Hussain et al., 2004). Lack of ownership or formal land titles, as is the case in South Africa, results in self-exclusion for the poor. A shift from low-value subsistence production to high-value market-oriented production is a key driver of income diversification and risk management. Similarly, newer production technologies and crop cultivars, geared to fit small farmers and fit small plots are a must for pulling the poor out of poverty trough irrigation (Hussain et al., 2004). Even if all the aforesaid conditions are met, when poor farmers remain unable to sell their produce in distant markets, due to market imperfections or high transaction costs, actual benefits of irrigation to the poor will fall short of their potential. Improvement in the governance and management of irrigation water would provide some indirect benefits to the landless poor and would provide considerable benefits to poor smallholders (Hussain et al., 2004).

In short, it is the “package” that matters for effective poverty reduction and not the mere supply of water.

CONCLUSIONS

From the review of literature, weak institutional and organisational arrangements and poor crop management practices by farmers seem to be the major factors leading to underperformance of most SIS. It is therefore recommended that SIS revitalisation programs should place: i) capacity building in basic crop and irrigation management practices, and ii) strengthening institutional and organisational arrangements prominently in their revitalisation agendas in any efforts to improve the performance of these schemes in South Africa. 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. 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. There is need to explore alternative cropping systems that would ensure viability in the face of limitations of labour and skills.

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