Shashe Irrigation Scheme:
An Inspirational Zimbabwean Model of resource management

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Cesvi Working Paper

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Cesvi believes strongly that helping the underprivileged in developing countries, or those in difficulty due to war, natural calamities and environmental disasters, does not help only those who suffer, but contributes also to the well-being of all of us on the planet, our "common home" that needs to be looked after for the sake of future generations.

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Acronyms

AGRITEX	Agricultural Technical and Extension Services
BB	Beitbridge
BBJ	Beitbridge Juicing Private Limited
CASS	Centre for Applied Social Science of UZ
CBNRM	Community based natural resource management
CEO	Chief Executive Officer
CL	Communal Land
DA	District Administrator
EU	European Union
FAO	UN Food and Agriculture Organisation
GIZ	German Federal Enterprise for International Cooperation
IMC	Irrigation Management Committee
MEI	Maize Equivalent Income
MoU	Memorandum of Understanding
NGO	Non Governmental Organisation
NRM	Natural Resource Management
PPCP	Private Public Community Partnership
RDC	Rural District Council
Schweppes	Schweppes Africa Limited
TFCA	Trans Frontier Conservation Area
UZ	University of Zimbabwe

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General Introduction

Cesvi is an Italian NGO, established in 1985 in Bergamo (Italy). In Italy and Europe, Cesvi carries out educational programs to develop global solidarity awareness, to increase the pool of donors and volunteers, and to influence private companies and public institutions to support cooperation projects for development. Cesvi is also working in 26 developing countries with humanitarian and development activities. Cesvi is a member of Alliance 2015, a strategic network of seven European non government organisations engaged in humanitarian and development activities.

Officially operating in Zimbabwe since 1998, Cesvi key areas of intervention include health, children and youth, emergency and post-emergency relief, management of natural resources, and food security.

Cesvi was amongst the NGOs campaigning since the early beginning for the promotion of the GLTFCA (Great Limpopo Trans Frontier Conservation Area) between Zimbabwe, South Africa and Mozambique. Its presence in the area since 1998 led to the creation of the Sengwe-Tchipise wilderness corridor, which enabled the effective establishment of the TFCA and contributed, through several consecutive projects (the last of which just ended at the end of 2015) to the CBNRM of the entire area.

Food security and agriculture were focuses since the early 2000's in the southern districts of Zimbabwe (Chiredzi and Beitbridge predominantly). Several projects and various researches were implemented in the areas of irrigation, CBNRM, income-generating activities (i.e. eco-tourism) promoting sustainable livelihood through resilience.

This document focuses on the experience and lessons learnt resulting from the EU funded project "Partnership models for sustaining viable land use initiatives and livelihoods in semi-arid TFCAs" implemented by Cesvi in Beitbridge district. This was an innovative 5 year project which merged the introduction of an innovative irrigation system (center pivot) to a community based citrus orchard. The adopted model, accepted by the scientific community and published in 2015 (Future of Food, Vol 3, No 2 (2015)) sees the transformation of the local economy from subsistence agriculture to commercial farming by allowing the local community to become resilient to climate change through a long-term, highly valuable, market centred crop.

Executive summary

Situated in the north western segment of Beitbridge District, Maramani Communal Land (agro-ecological region 5)[1] is a semi desert region with a population of approximately 4 000 people clustered in 20 villages. The Shashe Scheme is supplied with water from the Shashe River, a major tributary of the Limpopo. It originally comprised some 180 hectares divided into four blocks. It was constructed in the 1960ies. It finally collapsed in the 1980's. Its resuscitation was started between 2006[2] and 2008.

Irrigation schemes have featured as a rural agricultural development strategy in Zimbabwe since at least the nineteen thirties. Their appeal lay in the visible provision of efficient systems of crop production and food security in marginalised areas, thus satisfying the administration's approach to the guardianship of the native population.

A diachronic analysis of the efficacy of such schemes (colonial and post colonial) suggests that in terms of providing sustainable agricultural production, they have neither been cost effective nor have they provided long-term food security to their beneficiaries. This is certainly true of Shashe Scheme and all the others in the Beitbridge District.

The Cesvi managed Shashe Irrigation Scheme project is a bold attempt to develop a fresh approach to the management of communal land irrigation schemes in Zimbabwe and indeed the region. The scenario developed in collaboration with the community and its partners represents a paradigm shift to a model which aims at sustainability based on economic and jurisdictional autonomy. Market related and financial partnerships foster resilience through links with the wider national and regional economy. Local management, with constituent responsibility, ensures it is alert to the needs and requirements of its constituents. Support and mentoring by stakeholder partners provides monitoring, evaluation and innovation.

The five year project was launched by Cesvi in 2011, supported by EU funding[3]. The programme embraces a new management model based on commercial viability through a Private, Public, Community, Partnership (PPCP). New boreholes with submersible pumps have been sunk in the river bed. Modern centre pivot systems of water delivery have been installed.

An expressed wish by the community to establish a citrus orchard to underpin economic sustainability forms the cornerstone of the project. Maximum devolution of jurisdiction ("ownership" of the scheme

[1] **Vincent, V. and R.G. Thomas** 1961 *An agricultural survey of Southern Rhodesia: Agro-ecological survey. Government of Rhodesia and Nyasaland*, Salisbury, Southern Rhodesia: Government Printer.
[2] A project of the Centre for Applied Social Sciences, University of Zimbabwe with funding from FAO
[3] *Partnership models for sustaining viable land use initiatives and livelihoods in semi-arid TFCAs* – Grant contract DCI-FOOD/2010/258-368

by the farmers); a functional partnership with the private sector in regard to logistics and marketing mark a departure from the past. Support from the public sector is restricted to the provision of extension services, facilitating institutional development and validating governance, tenure and organisational legitimacy.

This paper traces the history of the scheme from inception in the early 1960s to its current state. It makes recommendations as to desirable interventions to build on the success of the programme to date and the replication of the management model developed at Shashe in neighbouring schemes in the district, and region.

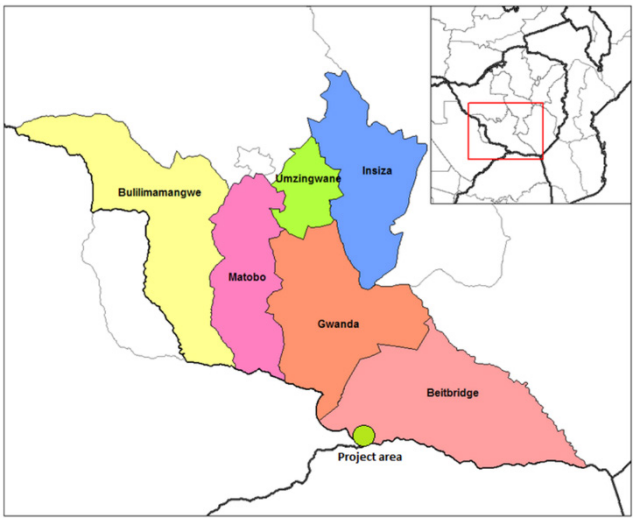
1. Background and Context

A. Geographical area and its economy

The Beitbridge district is in the south west segment of Zimbabwe bordered by Gwanda district in the north and Chiredzi in the south and east. Its western boundary is with South Africa and Botswana. Maramani Communal Land (area 397 square kilometres) is situated on the western corner of the district and the Shashe and Limpopo rivers form its west and south boundaries with Botswana and South Africa.

The most important economic driver in the Beitbridge and adjacent districts is irrigation farming. The Rural District Council has identified the expansion of citrus production as a major strategy for the economic growth of the district (5 Years Strategic Plan [2014 – 2018])[4]. Wildlife based eco-tourism (with associated cultural-tourism), livestock farming and mining are other important economic activities. Almost certainly it can be assumed that dry land, rain fed crop husbandry is a non-productive and economically non-viable option. Livestock farming has been successfully demonstrated over the last forty years to be a less attractive option than sustainable consumptive resource management of wildlife fauna (game cropping and eco-tourism).Thus any scenarios for the future that are developed should be grounded in combinations of irrigation farming, eco-tourism, well managed livestock farming, mixed with "game farming" and wildlife management. There must be a realistic understanding that coal or diamond mining may form a part of the developmental mix. For Maramani Communal Area and Shashe this means an association with neighbouring communities and institutions in the development of integrated plans to manage natural resources so as to maximize systems of sustainable consumptive resource utilization for economic development and improved livelihoods.

Figure 1: Geographical Location



[4] *"Thriving for Community Economic and Social Empowerment"* 5 Years Strategic Plan [2014 – 2018]

B. History & Heritage

History of the area and its people:

Maramani Communal Land (named after one of the senior traditional leaders) was designated as Crown Land during the Colonial period. It was thinly populated by mixed Venda and Sotho people, whose tenure spanned several hundred years. There was very little water inland from the Shashe/Limpopo Rivers. Settlement tended to be close to the rivers or such inland water as was available from natural wells and perennial springs or pools. In the late nineteen fifties and early sixties execution of large scale land tenure planning occurred, leading to re settlement of people living on land assigned to commercial farming. As a quid pro quo Government re-assigned Crown Land areas as Communal Lands for re-settlement of displaced families from commercial farms and ranches. Maramani was one such area. Boreholes were drilled throughout the hinterland and irrigation schemes were constructed along the Shashe River. Shashe (184 hectares), Jalukanga (60 ha) and Bili (20 ha) were all constructed as part of a general plan for the area. Shashe as the biggest, catered for at least half the villages in the southern section of Maramani and Jalukanga and Bili the other half: about twenty villages. The 20 villages were clustered into five communities each under a senior villager head. Thus, traditional governance is arranged in nested levels of jurisdiction so that all villages fall under a ward headman, Maupulo, and ultimately form part of the Chitaudze (Sitaudze) chiefdom which covers Maramani and Machichuta Communal Areas. Maupulo is thus the senior traditional leader responsible for Maramani Communal Land (ward eight of the District Rural Council) and exercises jurisdiction through his senior village heads, who in turn have limited jurisdiction over their village heads.

Shashe Scheme was built and run as a top down government controlled “technocratic” scheme in the mid 1960ies. The scheme was designed to provide livelihood opportunities to approximately ten villages in Maramani. From then until the early nineteen eighties the scheme was productive, growing mostly maize, wheat and sugar beans for local consumption.

Support from central and local government dwindled from the mid nineteen seventies and almost completely ceased by the early eighties. The scheme slowly deteriorated. For all practical purposes, it became defunct by the end of the nineteen eighties. Low production, low income and low farmer participation left the farmers’ with no financial resources, an inadequate skills set, and little sweat equity or incentive with which to repair and maintain the infrastructure. Through this period of decline and failure the scheme was (de facto) managed by the beneficiary farmers through an elected management committee. Devastating floods and cyclonic events further damaged the infrastructure so that by the mid nineties no more than between ten and twenty hectares were being irrigated. A

few attempts were made by well meaning but under resourced non-profit partners and the Department of Irrigation to revive the scheme but without success.

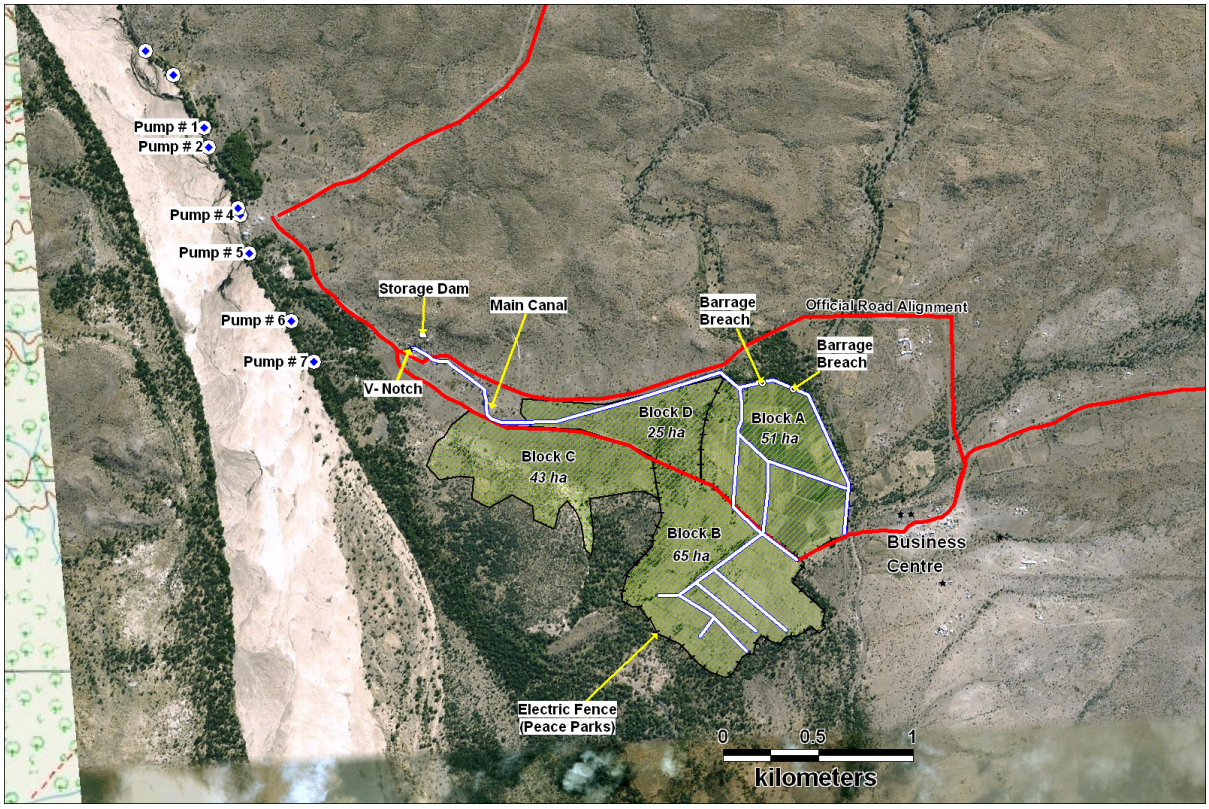


Figure 2: Shashe Irrigation Scheme original design

History of the Irrigation Scheme:

Irrigation schemes have had importance in central government's strategic plans for development of communal areas since the late 1930ies until the present.

Schemes during the colonial period were run by government staff and were designed primarily to provide food security. This appears to have been the intention when in the 1960s three schemes were built in Maramani: Shashe, Jalukanga and Bili, in close proximity to each other along the Shashe River. The one significant difference between these schemes and others in the country was allowing beneficiaries to remain living in their villages – up to 16 km from the scheme as they were livestock farmers and were reluctant to leave their cattle unattended.

Shashe was run successfully as a "technocratic scheme" from inception until about the seventies. The unsettled state of the country during the liberation war led to its near collapse. Little was apparently done to revive the scheme during the early years of independence. By the mid-eighties, it had all but collapsed. Serious weather related events in the late eighties and nineties brought about the final near total collapse.

Research indicates that communal area systems of managing irrigation have rested heavily on two persistent models: the "Technocratic" model and the "Local" model. Neither model has proved to be sustainable. Analysis reveals essential institutional and economic flaws in both. Thus, the model being introduced at Shashe seeks to create a sustainable system of management through a major paradigm shift involving three interlinked principal ingredients: (i) market viability, (ii) strategic partnerships and (iii) maximum devolved jurisdiction to local level.

Analysis has shown that schemes generally collapse for the following main reasons:

The "technocratic" model fails because technocrats do not have the capacity to manage down to field level. The transaction costs if properly charged to the scheme (and thus the farmers) are not cost effective. If Government is unwilling or unable to subsidize the scheme, all technical and managerial inputs cease or are curtailed. Without the financial support supplied by Government or NGOs, the scheme's infrastructure deteriorates and collapses. Local level management lacks capacity to manage the financial, institutional, marketing capacity requirements for sustainability (Manzungu & Machiridza, 2005).

The "local" model fails because technical knowledge is lacking, crops are grown largely for self-provisioning and do not realize sufficient income to provide adequate funds for maintenance and management costs. Local institutions fail to manage adequately as they lack capacity. Insufficient income is generated to levy the farmers and infrastructure collapses after a period of reduced

While addressing the Shashe model, revisiting the conventional models as described by Bolding (2004) is instructive.

The "Technocratic" model (factory paradigm):
Plots and hydraulic infrastructure was owned, managed and maintained by government. The schemes were promoted to augment food security in arid areas with low livelihood possibilities. Cost of maintenance was justified as a means of reducing famine relief measures. Economic viability was not a limiting factor. Plot holders had no discretion as to crop selection, water distribution and husbandry. Such marketing as took place was through government controlled co-operatives. A levy or rent was imposed on plot holders as a control measure rather than a meaningful contribution to running costs. While Government finance and controls were efficient and effective, the schemes were reasonably productive in terms of crop production (usually maize and wheat). As soon as Government lacked the capacity to finance and manage the schemes they invariably collapsed.

The "Local" model (African irrigation paradigm):
These schemes were usually smaller than the "technocratic" schemes and were generally the result of local initiatives by district officials supporting community efforts to improve existing self-help initiatives. Thus, plots and infrastructure was in usufruct ownership by "local" farmers. Irrigated production is only one of their livelihood strategies. Farmers optimize their activities along rationales of risk spreading and labour productivity and only after achieving food self-sufficiency may surplus produce be sold. Irrigated production is subsumed in existing kin-based organization of production and consumption. Farmers decide on crops grown and water distribution is reflection of authority (on and off scheme). Significantly, economic viability is not a major concern. Infrastructure maintenance while a group responsibility is open to abuse by free riders and lack of institutional clarity. "Rules of the game" are ill defined and poorly enforced. Bolding (2004, pp. 9-10) calls it the 'African Irrigation Paradigm.'

productivity. The caveat to the above is that small schemes have a greater chance of sustainability and micro-schemes (irrigated gardens run by individual families) have a very high level of sustainability.

Shashe Scheme was built and run as a "technocratic" scheme from about 1960 to the early nineteen eighties. Because support from central and local government dwindled and almost completely ceased, the scheme collapsed. Since then the scheme has (*de facto*) been managed by the beneficiary farmers through an elected management committee. Devastating cyclonic events further damaged the infrastructure and it finally collapsed.

Shashe, Jalukanga and Bili, differ from most other colonial schemes in that the members do not live on the scheme in villages dedicated to this purpose, but are scattered amongst their home villages along the river and hinterland. This has a considerable influence on productivity, livelihood perceptions and the governance of daily priorities. Its influence upon the emergence and development of the model described below should not be underestimated in terms of distribution of obligations and the rewards of participating in the scheme.

C. Climate and environment

Agro-ecology:

Zimbabwe is classified into five natural regions or farming zones. Vincent (ecological and land use aspects) and Thomas (pedological aspects) originally classified the country along mainly agro-climatic criteria.

> *"A Natural Region is defined … as a relatively large area where agricultural development is, and will be, conditioned by one or a few dominant natural characteristics." (Vincent and Thomas, 1961)*

For "over four decades these categories have been the main policy frame for strategic and regional planning. At a broad level they are useful" with mean annual rainfall being the main determent. They tend to "gloss over (other) factors" (Murphree and Mazambani, 2002).

Beitbridge District and Maramani Communal Lands fall into Natural Region Five:

> Region V – Lowland areas generally below 900m and covering 27% of the country. Erratic rainfall usually below 650mm. Suited to intensive livestock production or game ranching. (Murphree and Mazambani, 2002 after Vincent and Thomas, 1961)

Vegetation falls mainly into two types in this region, that common on granite-based soils and that found on paragneiss. On the granite sands, the overall composition comprises *Colophospermum mopani, Comiphora spp., Terminalia spp., Adonsonia digitata, Albisia harveyi, Kirkia acuminate, Combretum spp., Acacai nigrescens* etc., with common shrubs including *Grewia spp., Euclia divinorum, Croton gratissimus* etc. Grasses are mainly *Aristida spp., Eragrostis, Panicum maximum, Tragus, Digitaria* etc.

On the paragneiss a more open bushveld occurs because the soil has better moisture relationships. Mopane is still dominant but more abundant *Acacia nigrenscens* is noted, with *Combretum apiculatum* and scattered *Adansonia digitata*. Other vegetation is similar to that found on the granite sands.

Farming Livelihoods in Region Five:

The population of the Communal lands in Beitbridge West (Maramani, Machichuta and Masera) is in the region of 11000 (1750 households) in an area of approximately 1500 square kilometres.
The total area of Maramani Communal Land, the subject of this case study, is 397 square kilometres or 39700 hectares. Current available figures for livestock are cattle 4120, goats and sheep 21000, and donkeys 2048. Extrapolating the livestock figures into 11000 livestock units, the ratio of livestock to area is 3.6 hectares to 1 LSU. (This does not take into account human settlements and rain fed farming

fields.) Cumming (2003) reports: ***"with minimal external inputs and an average annual rainfall of 350mm the area of land required by a household is 5ha of arable land."***

To emphasize the reality of the situation it is noted that rain fed crops are reaped in only about one year in five. In most years, the yields from maize or sorghum are insignificant. Apart from a few low quality "cattle" melons, considerable effort is put into production only to see crops wither and die of thirst, or be consumed by elephant or untended livestock .

This is the stark reality of the extent of land utilization and over grazing. It is without doubt the most serious environmental management issue facing the Maramani and indeed the Beitbridge and other Lowveld districts. It also highlights the reason why food security for the families' resident in these barren lands is an ever present problem. As Cumming states: "***The key issue of population to resource base ratio will clearly have to be dealt with."***

Irrigation farming:

The three major rivers (Limpopo, Shashe and Umzingwane) that traverse the district are sources of irrigation water. Irrigation on commercial farms has been undertaken for decades. Many different crops have been tried including cotton, maize, wheat and beans to name the main ones. From about the mid nineteen fifties, citrus became popular.

In the communal lands, apart from micro-irrigation of small gardens for cultivation of vegetables, irrigation was only introduced in the 1960ies. The main purpose of the schemes was to provide food security for the communal land inhabitants. Maize, wheat and beans were the main crops. Schemes collapsed when government support ceased in the seventies and eighties.

With the growth of the citrus industry within the district, and the establishment of a juicing factory, citrus has become the major produce grown under irrigation on commercial farms. It was introduced on a small scale at Shashe and Jalukanga in the nineteen sixties but with no guaranteed market at that time, coupled with the collapse of infrastructure and lack of water most trees had died by 2006.

2. The Project

Background

The Shashe project, commenced in 2011. It was primarily funded and supported by EU through Cesvi, with support from Schweppes/BBJ, GIZ, Nottingham Estates, BBRDC, the central Government techno-bureaucrats (district team) and the academic community. It builds on the work of previous interventions (Cesvi 1999- 2003[5], Peace Parks and partners TFCA interventions 2003/7; FAO/UZ (CASS) 2006/8.) All these interventions, which focused on conservation and community based natural resource management, identified irrigation schemes as important socio-economic drivers, as well as critical to the recovery and development of the entire eco-system, not simply its human component. Thus, even the current programme has included in its methodologies the effects of integration with the wider Maramani.

1. The Model

The present model introduced at Shashe is based on research carried out over a number of years at regional and national level (i.e. *Water Research Southern Africa (WARFSA) program*) and confirmed by local participative research with and by the Shashe Community. The work undertaken by Mead (2001), Cumming (2003) and Latham (1999 & 2005) as advisers/ consultants to Cesvi, who has been active in the southern Lowveld of Zimbabwe since 1998, contributed to its evolution. Most important of all it incorporates the views and scenarios formed in consultation with the community, local leadership and other stakeholders.

It includes the following:

- Devolution of "ownership" to beneficiary farmers who form a management organization with constituent representation.
- Considerable institutional development, the acquisition of skills and additional competencies sufficient to manage the complexities of a commercial enterprise. This is a long process that takes time – up to five years – and patient understanding (Murphree, 2004).
- The creation of partnerships with the private sector, focused upon seeking market guarantees, crop loan finance and technical support for economically profitable crops to be grown in preference or addition to crops grown for food security.
- Support from extension agencies (NGOs, local and central government and private) is confined to assisting the farmers to make the transition to one of commercial sustainability with a food security element or Maize Equivalent Income (MEI) (Osofsky, 2005, p. 42).

[5] Sustainable development and natural resources management in southern Zimbabwe (Cesvi, 2001)

- Replacement of obsolete technologies (well points and flood irrigation) with a modern and sophisticated irrigation system (submersible pumps and ultra-high center pivots) designed and modified to fit the needs of the community and the agricultural regime (coexistence of citrus and inter-cropping).
- Citrus represents an innovative introduction on a community-managed scheme.
- The adoption of inter-row cash cropping at the behest of the community, in order to enhance immediate returns of food and funds for development and maintenance, represent a further innovation departing from the traditional citrus culture. In doing this, immediate cash returns are made available by utilising land between the trees, normally remaining uncultivated on citrus monoculture.
- The 'shift' from subsistence agriculture to a community-based commercial enterprise.

  The development of the new model is based on regular and iterative use of systematic, strategic, scenario planning referred to as adaptive management (Jiggins & Roling, 2000; Latham, 1999, 2005; Murphree, 2001).

By goal setting, and regular, iterative self-assessment, farmers are assisted to develop and change perceptions in the light of newly perceived opportunities, technologies and agronomic innovations and to adapt and change their short-term goals while retaining their vision and overall objectives. Facilitators, advisors and techno-bureaucrats are also facilitated to understand perceptions and worldviews other than their own. The new model emerging thus embraces a common worldview and vision that is centred upon rural perceptions of food security ("food crops") as a principal objective, but now married to one of long term commercial sustainability – citrus – ("high value crops") and the investment of acquired income in scheme management and maintenance with individual profits accruing to participating beneficiaries (shareholders).

2. The Process

A demonstration/trial plot or 'mini-farm' started at the outset of the project was and continues to be a useful adjunct to the development and introduction of farming and technological innovations, hands on management, and identification of problems. The rural resource and training centre, offices and workshops situated adjacent to the demonstration plot, makes what the community now calls "The Demo", the nerve centre of the scheme. The creation and maintenance of an on-going learning organisation with the resilience and vision to embrace a partnership between the community and its external partners becomes an essential element of the centre. All activities and practises are viewed as part of an on-going learning process, and help develop a "learning organisation" (Senge, 2006; Senge & Sterman, 1992).

3. Partnership

Partners are sensitised to the fact that the scheme is premised on common property management with tenure ("ownership") vested in the community of beneficiaries (Rukuni, 1994). Thus techno-bureaucrats and other resource providing agencies have to understand and adapt their own interventions to the reality that their empowerment and status lies in delivering an innovative, sapient support role, not a directional or authoritarian one; that the management structures of the scheme are responsible to their constituents and not to outside officials or institutions (NGO officials, Rural District Council, line ministries, etc.) Through lengthy debate and practical trial and error a dynamic institutional framework develops, upon which the organization and management of the scheme can move forward. This includes the formulation of a constitution and bylaws that are applicable, enforceable and enforced in partnership with traditional institutions (courts of headman) and local law enforcement agencies (Police, Environmental Management Authority and Wild Life Management). This answers one of the essential requirements of common property management (Ostrom, 1990).

4. Infrastructure Development

Hand in hand with the institutional development at Shashe is the task of upgrading the infrastructure. Introduction of the center pivots and related installations fell to Cesvi. It involved some bold decisions such as the sinking of boreholes for submersible pumps deep in the Shashe River bed to replace the unserviceable old well point system; replacing degraded asbestos-cement delivery lines from pumps to field edge; extensive bush clearing and land preparation for three 30 hectare center pivots that replaced the in-field trapezoidal canals, siphons and flood irrigation system that had been completely destroyed by neglect and cyclonic events.

Figure 3: Demonstration plot with 3 ½ year old trees ready for harvesting (Jun 2015)

In addition 22 000 orange trees were supplied by Cesvi and planted by the community. Intercropping between the young trees became an established practice. Crops such as seed beans, squash, sweet potatoes, rape (canola) cabbages and maize are cultivated, either on contract for cash, or for basic food requirements or both.

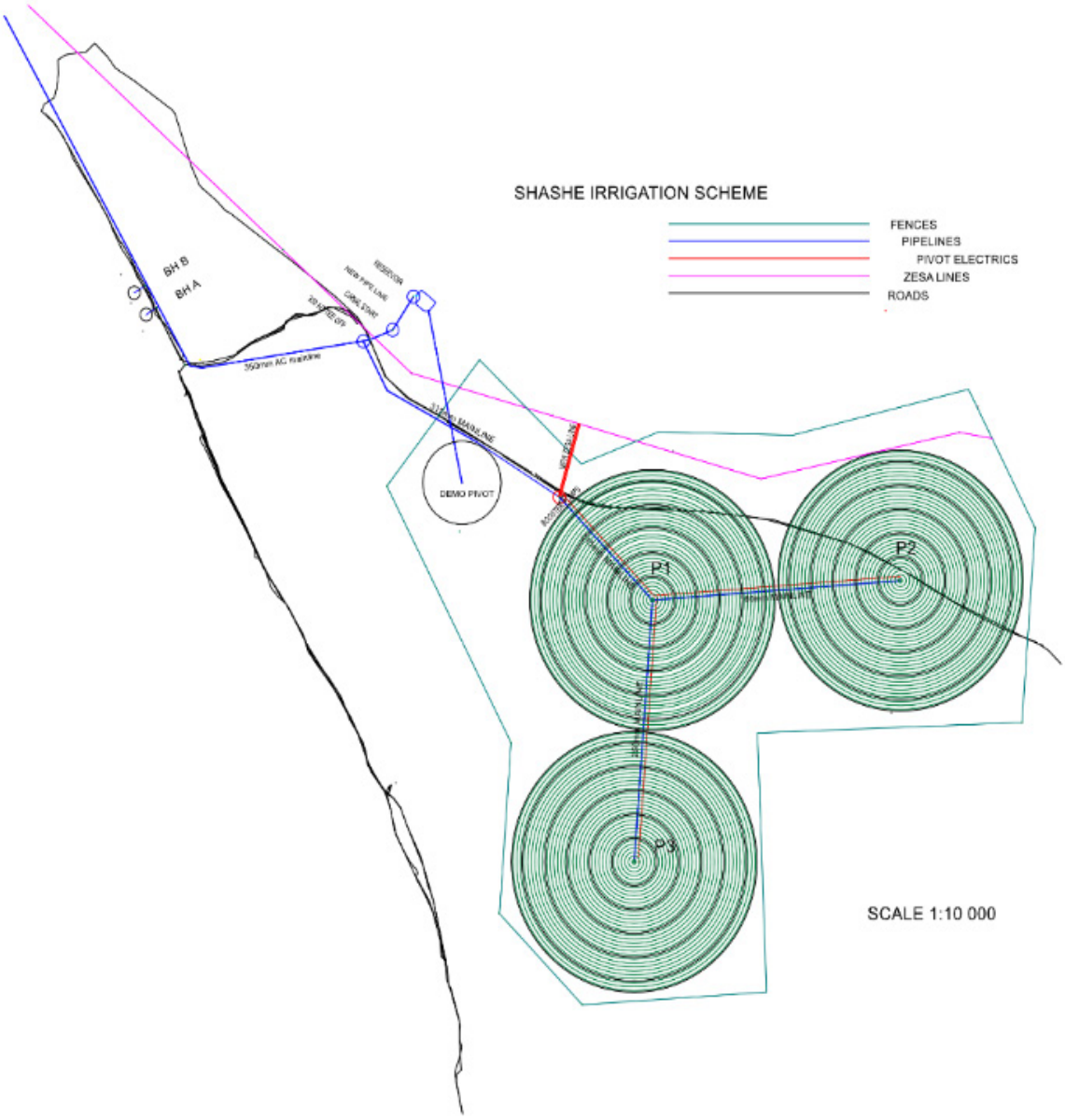


Figure 4: "Shashe Citrus Orchard" installation

While this activity was underway, the community was also involved in attempts to renovate the two arable blocks known as A and B (See Figure 5). This included work on a breached barrage, construction of a weir and work on canal repairs. Alas all this demanding work was for nothing. An exceptional flash flood in a minor tributary of the Shashe that is normally diverted by the barrage breached this in several places and wrought havoc over the two blocks, destroying all the gains that had been made. This disaster illustrates the nature of projects such as Shashe: surprise events can never be ruled out.

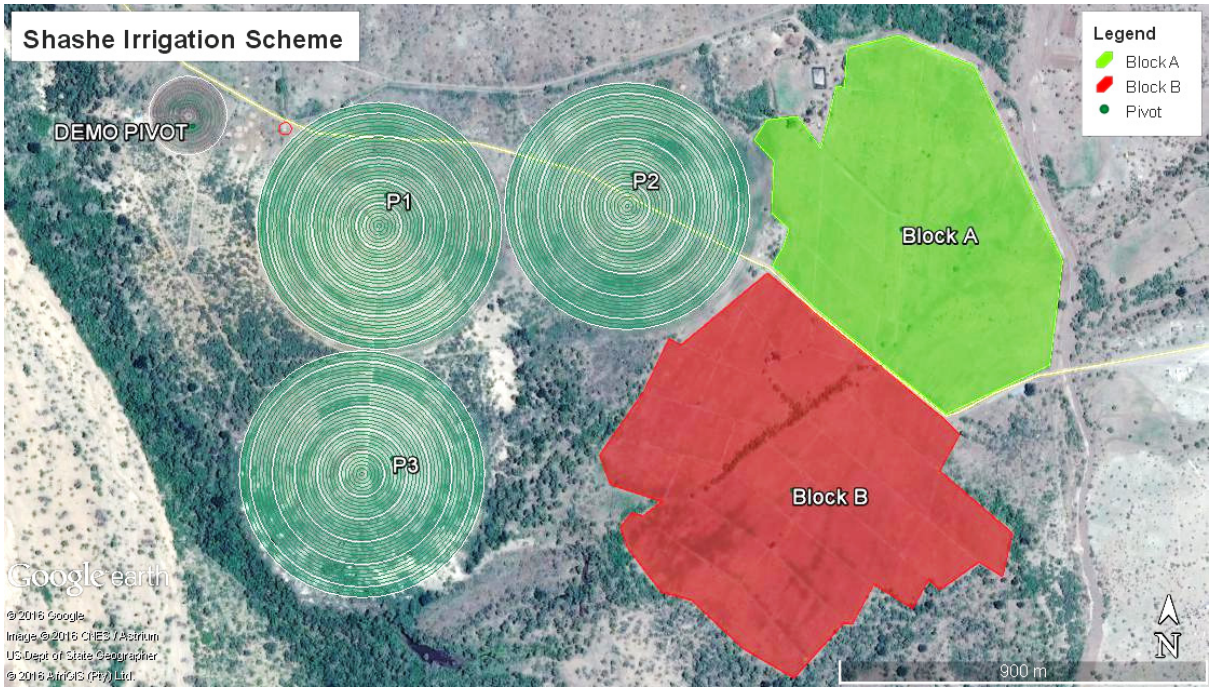


Figure 5: Shashe irrigation scheme present design

5. The Institutional Arrangement

The Management Committee (IMC) had to deal with this disaster as well as supervise its members for the urgent need to plant orange trees under the third pivot commissioned by the end of 2014; complete allocation of trees to beneficiaries; negotiate contracts with Agri-businesses for seed bean and crops; tend to existing trees planted in previous years; maintain inter-row crops; attend meetings and workshops (some unrelated to the scheme) as well as maintain their social responsibilities. This daunting array of activities they have managed with commendable energy and maturity. This proves that communities, given the incentives and authority over their own affairs, are generally resilient and responsible. None the less, the learning organisation that is Shashe community has still to experience their first season of mature trees when they harvest their first major orange crop, transport it to market and receive payment and budget their income against expenses.

A major strategic objective inspiring the colonial and post-colonial policy on irrigation schemes was an attempt to provide food security, to mitigate or avoid having to provide famine relief in the vulnerable low veld districts. This was certainly the case in Maramani. Shashe was designed to help the ten southern villages, Jalukanga and Bili the 10 northern. Indeed, this objective went some way to justifying the expense of the primary development of the schemes and the subsequent heavy subsidisation (Bolding, 2004).

We have given an analysis of why these schemes eventually collapsed and the rationale behind developing a new sustainable model. It is necessary to demonstrate that this model when it reaches

maturity should once more be capable of providing the food so necessary to augment other livelihood strategies in Maramani and similar environmentally disadvantaged districts. The Shashe case study illuminates this important component of the model's design and purpose. It must be born in mind, that the final concept of the Shashe model was largely influenced by local knowledge, which proved to be generally wiser and more aware of local dynamics and indigenous knowledge systems (IKS) and strategies than some theories and implementing plans brought by development practitioners, technocrats and commercial operators. In particular, their leaders were acutely aware of the community's need for the assurance of food security and for all agricultural plans to include this perceived element so vital to their well-being.

When the Cesvi plans for the Shashe Project were being drawn up by the technical and administrative professionals, they logically included all four blocks in the projected citrus orchards. Only after the project was accepted and became operational did serious discussion with the local community ensue. The farmers were adamant that Block A and B be reserved for food crop production (the maize and wheat cycle). They drew attention to a workshop held in 2007 where this arrangement had been agreed. Despite arguments and scenarios presented to them about the advantages of cash crops (as MEI) and particularly citrus they remained obdurate. Wisdom acquired by outsiders may now well see the logic behind their stance. No one at that stage (and indeed ever) will be able to guarantee that citrus will, for ever, be the cash crop that it currently appears to be. Bolding (ibid) points out that his extensive research in the Save Valley area (similar to Shashe in climate and livelihood strategies) noted that a constant strategy amongst irrigation farmers was to place food security before economic gain. The time honoured peasant belief in securing enough food before contemplating any adventurous farming innovation holds true. Also, more enlightened thinkers at these early discussions were concerned about the obvious risk of "putting all their eggs in one basket".

In the light of the above, Blocks A and B will remain reserved primarily for food security. It is an unfortunate turn of fate that the efforts to restore them to productivity failed. Nevertheless, it is a firm commitment of the community to bring them back into production.

6. The Establishment of the Trust

As far back as 2007, the community leaders expressed an interest in forming an institution capable of autonomous corporate governance of their scheme. They had heard of trusts as Cesvi had been instrumental in the formation of a eco-tourism campsite quite close to Shashe Scheme. At a scenario-modelling meeting attended by the then IMC and ward councillor, the facilitator outlined the basics of a simple community trust. The model that emerged was dominated by the strongly felt need for an institution that could protect the scheme from powerful outsiders, and that could control and manage

its own finances. At the same meeting, the decision was taken to seek partners preferably from the private sector to help rebuild the scheme. The notion of the trust was thus inspired by the wish to protect the beneficiaries from exploitation by private partners, the obvious need for a corporate persona so as to be able to open bank accounts and enter into contracts on behalf of the community and the like. The alternative of forming a cooperative was rejected as being too much under the influence of government bureaucrats.

Throughout the length of the current Cesvi programme, the idea of a trust has been raised from time to time. Only once the scheme started to earn substantial amounts of money through contract farming, did the formation of a trust become a realistic objective. The structure and functions of the trust were subjects debated at informal district workshops as and at local level under the umbrella of the IMC. The result of these deliberations was then submitted to a trust lawyer for drafting into legal language. This in turn was returned to the IMC for ratification and finally put to a mass meeting of all beneficiaries. They unanimously endorsed the document and the trust was born in early 2016.

The trust is structured as follows;

- Four permanent no-elected trustees consisting of the District Administrator (ex officio), the CEO Beitbridge RDC, ex officio; Headman Maupulo (ex officio) and Mr. A Mbedzi, Shashe resident and retired RDC CEO
- Six elected members of the IMC (chairman, vice chairman, secretary, treasurer, and two elected committee members) chosen by the IMC.

The IMC is the managing body of the trust and is responsible for routine administration of the scheme. The Trust and IMC are served by an irrigation manager. He acts as a link between the IMC and the trust. The reports to both bodies to which he is both their principal adviser and chief executive officer responsible for all aspects of the scheme's management. The manager and his staff provide the necessary secretarial back up for the IMC and Trust as well as day to day book keeping. Financial management and advice is provided by a professional firm of accountants.

3. Methodology

Introduction

This chapter is concerned with management and governance of resources. Governance implies a need to identify acceptable systems of accountability and representation. The broadly labelled system of 'Western democracy' is only one such system. Yet Western worldviews, articulated by their notions of democracy and economics, have profoundly influenced the dynamics of resource management from the smallest scale of local units of governance to those of national polities. The dominance of Western ideologies, grounded in their perceptions of representative government and economics have thus intruded and influenced the governance of developing countries, often with consequences that have inhibited or weakened local level management (Keeley and Scoones, 2000; Murphree and Mazambani, 2002).

This chapter moves towards policy advocacy for a greater recognition of institutions that are an expression of epistemic, indigenous notions of governance, systems that display a healthy holistic involvement of local communities and are congruent with their perceptions and worldviews.

Indigenous systems of resource management, based on local knowledge of ecological conditions and congruent with cultural and historical imperatives (worldviews) are the most likely to provide strategies for sustainable and efficient natural resource management. Community based natural resource management (CBNRM) requires defined spatial and social units of management. The traditional Shona ward (*dunhu)* best meets the defining criteria of a traditional community with the resilience, cohesion, and legitimacy to provide integrated, sustainable management of natural resources in Zimbabwe's communal areas. For the purposes of this chapter the ward is the benchmark for defining a community, though the Shashe Irrigation Scheme "community" also fulfils the criteria and for practical purposes is delineated as a functional community within the over-arching Maramani community. (See remarks elsewhere as to scale and nested levels of jurisdiction.)

> ***"It is clear that the first step needed in the establishment of appropriate local level common property resource management institutions is a process of participatory research designed to consult with local communities on existing resource use patterns, the desired changes in property rights, and the appropriate institutions to regulate these rights. Such a process must, in the final analysis, utilise local technical knowledge as far as possible rather than ignore its existence." (Murombedzi, 1990b)***

This methodology employed in Maramani CL in regard to Shashe Irrigation Scheme, offers a response to Murombedzi's suggestion. Our methodology and research supports the proposition of

'*jurisdictional parsimony*'; "*scaling down to the local and then scaling up through delegated aggregation to deal with functional and ecological management*" (Murphree, 2001). "While the centre matters critically in political terms, it is evident that the 'local' is where 'development' initiative and entrepreneurship are more dynamic" (Hulme and Woodehouse, 2000). One reason for this is that in "*conditions of high complexity, information becomes much more relevant when those who gather it are as well those who use it*" (Roe, 1998). The "Shashe Experiment" is a participatory engagement with a local level community to determine the best possible scenarios for the management and conservation of their resources – a participation they themselves requested.

1. Systems thinking, scenario modelling, planning and sustainability science:

In most so-called participatory programmes, it is *locals who are invited* to participate. The methodology advocated in this paper is based on "*inside-out planning for eco-system management, where local leaders and residents are themselves the experts and where the planning process is itself initiated and guided from within the local eco-system*" (Roe, 1998). Thus academic and outsider resource person's involvement *"should be invited rather than imposed, where the outsiders are directed rather than directing, and their role is that of facilitators"* (Murphree, 2001) and conduits for information and technological innovation.

The critical need for sustainable natural resource management has created a new branch of predictive science that employs scenario modelling, usually on global or continental scales, and on large temporal scales. Scenario modelling often uses mathematical simulations to predict future trends and scenarios. (Meadows *et al.* 1972 and their sequel in 1992) But because these modelling systems generally apply to "*long term futures in complex systems"* there has been a "*shift (to) greater attention to cultural and institutional variables"* (Murphree, 2004) thus "*internalising human choice into sustainability science*" (Swart *et al.* 2004). By inference this implies a methodology of adaptive, iterative experimentation, sometimes accompanied by "game" playing and modelling – "experimentation in a 'virtual' world" (Senge, 1990).

Scenario modelling and planning derives from 'systems thinking' (Senge's 'Fifth Discipline'):

> "It is the discipline that integrates the disciplines, fusing them into a coherent body of theory and practice. Without a systemic orientation there is no motivation to look at how the disciplines interrelate. By enhancing each of the other disciplines, it continually reminds us that the whole can exceed the sum of its parts. (…) vision without systems thinking ends up painting lovely pictures of the future with no deep understanding of the forces that must be mastered to move from here to there. Without systems thinking, the seed of vision falls on harsh soil." (Senge, 1990:12)

> "Systems thinking is a conceptual framework, a body of knowledge and tools that has been developed to make the full patterns of systems clearer and to help us see how to change them effectively." (Senge, 1990)

System thinking was made operational by types of organisation that were prepared to experiment and take risks and survive by innovation and the ability to adapt strategies by iterative tactical manoeuvres: namely corporate businesses. (de Geus, 1988; Senge, 1990). Business relies heavily on putting ideas developed by teams into practice, sometimes by scenario modelling, sometimes in field conditions and more usually by a combination of these methods. Above all, however,

> "business is the locus of innovation in an open society. Despite whatever hold past thinking may have on the business mind, business **has a freedom to experiment missing in the public sector and often, in non-profit organisations. It also has a clear 'bottom line' so that experiments can be evaluated, at least in principle by objective criteria**." (Senge, 1990)

This involvement of business organisations in participatory partnerships with NGOs and community organisations is a thus a pivotal component in the development of the new model of public, private, community partnerships.[6]

De Geus of Royal Dutch/Shell is quoted as saying that

> "*continuous adaptation and growth in a changing (business) environment depends on institutional learning, which is the process whereby management teams change their mental models of their company, their markets, and their competitors. For this reason we think of planning as learning and of corporate planning as institutional learning*" (Senge, 1990)

2. The Learning Organisation: Adaptive Management

What Senge calls '*a learning organisation'* inspires the notion of learning (not just 'capacity building' – though this would be an apt description if the phrase had not become so hackneyed - nor simply 'being taught'.) Received wisdom is challenged, our own hidden worldviews are held to scrutiny. It includes the ability to carry on constructive dialogue and discourse that balance enquiry with advocacy and encourages people to expose their own thinking effectively and make that thinking open to the

[6] It must be noted that the inclusion of corporate players in the Shashe partnership came not without its problems. Such people are profit oriented. Time and labour management are thus of high importance. Communities who rely on volunteer workers, that are traditionally more attuned to crops grown primarily for food security appear irrational to the commercial farmer, while to the subsistence farmer, who prioritises his time and objectives from a different perspective., the commercial farmer seems obsessed with detail and haste. Worldviews in apparent contradiction can create tensions and misunderstanding. Facilitators must be vigilant and innovative in their task of bringing these seemingly irreconcilable views together to build synergies. This is the epitome of building a learning organisation.

influence of others. It is these philosophical notions of liberating 'social energy' (Uphoff, 1996) that encourage the sorts of processes that include

- Scenario modelling by the community. This means building a desired future for their locality, based on their material and cultural 'felt-needs' in relation to their modes of production and their resources (both natural and human) and then considering various scenarios for the realisation and development of the dream to reality. This is the exploration of "what if " - exploration of alternatives described in physics and mathematics as "phase space" and the "adjacent possible".[7]

- As a natural progression will be a requirement to address constraints and possible alternatives.

- Borrowing from the techniques of strategic planning, these components can best be realised by focus groups using Stategic planning SWOT analysis techniques and methodologies. A SWOT analysis leads by natural progression to the development of an action plan and *scenario modelling then becomes scenario/strategic planning* based on an interpretation of the identified issues and variables. The action plan, with defined *goals and time frames evolves into a continuous process of* adaptive management "*through regular and iterative evaluation and adjustment (…) If progress is not satisfactory, the reasons are examined*" (Murphree, 2004:3) and a revised action plan for the next period is negotiated. The vulnerability of strategic planning, resulting in the "Forgotten in a Drawer" syndrome is over come. Combined with regular "what if" sessions where participants have to plan for scenarios outside their normal expectations and perceptions leads to further innovation and most important of all acceptance of change as a natural ingredient of a learning organisation.

The methodology outlined above has few startling innovations. Successful programmes were conducted in Zimbabwe (Latham 2006) and Uphoff's narration of his Sri Lankan experience is seminal (Uphoff, 1996). What is emphasised here is the genuine requirement that the primary directors must be the local community or communities[8]; and an increased liberty to experiment – to allow the natural tendency for local level communities to adapt institutionally to the changing demands of new scientific innovation and technology and to run the programme over an extended period. These requirements do, however, require 'breaking the paradigm'. Encouraging a 'learning organisation' implies the

[7] For more detailed explanations of the intricacies of "futures" studies as a discipline, see Cohen and Stewart.
[8] For the purposes of this paper a community is equated to the residents of a traditional ward (dunhu).

courage and the time to allow mistakes (experimentation) to be made and through careful monitoring and self evaluation encouraging iterative adaptations to "fit" the changing scenarios.

3. Resource Centre and Demonstration Plot: Agricultural Technical Extension and Training

The resource centre is the hub of all activities on the scheme, from training days, to focus group discussions and workshop, to IMC meetings, and the weighing and storing of crops pending sale and despatch. The value of this multi-purpose facility, as a "hardware" component of the over all growth of the Shashe Scheme is incalculable.

Integrated into the institutional planning and management development is the exposure of the community to new innovations and technologies: crop (and in the case of Shashe) citrus husbandry, including trials of new cultivars, marketing, accounting and budgeting administration. Running concurrently with agricultural extension training was/is the introduction of new technologies: centre pivots, submersible pumps, booster pumps and generators, solar power and energy conservation, water harvesting etc.

From the outset of the programme the development of a demonstration plot or "mini farm" was deemed an essential tool. This was supported by FAO/CASS in the inception phase and later by the EU/Cesvi intervention. Indeed, Cesvi's support included the construction of a resource centre. This includes workshops, storerooms and incorporates a small training facility with over night accommodation for resource personnel. The demonstration/experimental/trial plot was also supported by Beitbridge Juicing Company (now a part of the Schweppes organisation) and partner in the development of Shashe, who donated a 2 hectare centre pivot for the plot. It has proved to be a major asset in the on going learning process.

Farmers receive exposure to the efficacy of new technology, to the practise of inter- row cropping, to the critical issues of timing, biological pest controls, and the whole cyclical requirements for husbandry and harvesting marketing and proper accounting and record keeping. Such exposure has been facilitated because the centre is the hub of the scheme. Workshops and meetings and discussions take place there. Harvested crops are weighed and bagged there; and workers draw tools there– all can be said to pick up on what happens on the demo plot almost by a process of osmosis.

4. Techno-bureaucrats and external facilitators:

Any methodology designed to respond to invitations by local communities to engage in scenario modelling through a set of longitudinal internally designed successional experiments will initially have to overcome some daunting obstacles. In the forefront will be the possible resistance of the techno-bureaucratic fraternity that occupies the 'high ground'. One can predict a reluctance to permit the

sort of freedom to experiment that would be essential for the success of this sort of methodology, particularly as it predicates changes to power over resources.

> "The State, its private sector allies and its bureaucracies have their own appropriative interests in local resources and the state is loath to legitimate local jurisdictions in ways that diminish their ability to claim the benefits of these resources. This tendency, more than any other factor, is responsible for the failure of programmes ostensibly designed to create local natural resource management jurisdictions" (Murphree and Mazambani 2002)[9]

The methodology suggests that the external participants (development practitioners) must truly be facilitative and never directive. Facilitation must be sensitive and in harmony with local worldviews and therefore with "African Holism."[10] (Latham 2006) In the very strict sense of the word, facilitators must be capable of dialogue.[11] Their role will include offering information not available to the local participants, and imaginatively adapting specialist techniques to local conditions and which are acceptable to the local community. A training component in the use of new or alternative appropriate technologies and techniques would also fall to the external partners when requested to do so by their local partners. At all times, however, the external partners would be in support, rather than in a lead role.

In the case of Maramani, a cordial relationship with the District Administrator (DA) and the Council CEO and their "district team" has been maintained for a period of nearly ten years. Throughout the life of the project, when opportunity arises, workshops and informal briefings[12] have taken place, thus ensuring the district head and his team have been cognisant of progress.

Through time a multi-disciplinary "panel" of researchers/facilitators/extension officers and corporate members have joined the programme, thus involving government and non-government bureaucracies, and central and local level stakeholders. [13]

In practical terms it is not possible to engage with all these people all of the time. Participation is periodic, depending on requirement, availability and commitment. Thus the method of entry into the

[9] See also Boutinot (2002) for institutional problems caused by state foresters and local jurisdictions in Senegal; Lentz (2002) for conflict between traditional and new 'elected' leaders in Ghana; Nijenhuis (2002) for similar institutional dynamics in Mali. Chapters five and six of this volume provide detailed case studies from LSCF and CL communities in Zimbabwe.

[10] African Holism, is defined as a kinship system bedded in a religion/worldview with an ecological ontology.

[11] Dia-logos to the Greeks meant a free flow of ideas and meaning through a group, allowing the group to discover insights not attainable individually.

[12] The DA and or CEO are briefed on a monthly basis as is the local traditional leader Headman Maupulo. Local focus groups and monthly meetings with the IMC are used as fora for discussion and are facilitated by the RDC Community Development Officer and the writer

[13] It must be stated that one of the problems that has to be addressed is the lack of capacity of many state extension departments. By their own admission the AGRITEX head of district openly stated that his staff lacked capacity and needed support in citrus, with transport and logistics. How to incorporate such support into the scheme's on going programme is a real problem and has yet to be properly addressed.

community is particularly important if the intervention is to be seen for what it is: an invitation to participate in a planning, development and management programme.

5. Introduction of outsiders to the communities:

With regard to the traditional institutional structures, protocol would suggest it would be at the formal invitation of the chief, his ward headmen, and village heads representing community interests that the programme would be initiated. (In districts where traditional religious observance of the ancestral spirits (*mhondoro)* is active, spirit mediums (*masvikiro)* may also need to be included.) Obviously such "invitation" would in practical terms follow initial introduction by a representative of the RDC or DA's office.

Once the formalities are completed, the response on the part of the external team would be a request to be introduced to the community/ies by the chief, his senior advisers (*makota*), ward headmen, local RDC councillor(s) and such others as they may wish to be present. Such a meeting should then be replicated at the level of the ward and of the villages included in the programme. At each successive level the introduction should be made by a representative of the higher level (i.e. chief or his representative introduces team to ward headman and asks for them to be received; ward headman does same for each of his village heads and village head for his households). We **went through this process in Maramani. It offers powerful symbolic testimony to the relative status of the participants. Maybe because of this approach, within the core area of Shashe, most programme partners are now accepted without the superstition and caution so often encountered in rural communities.**

4. A Brief Citrus Agronomy

SHASHE CITRUS RECOMMENDATIONS

The development of a satisfactory orchard depends largely on the condition and general appearance of the trees. Therefore the IMC should only Purchase young trees from a nursery that is registered with the South African Citrus Improvement Scheme. Trees should not be too old or too big, otherwise they are likely to be pot-bound however larger well grown seedling trees are preferable to weak young trees.

At the outset, it must be understood that the development of citrus orchards can take up to six years to significant viability and longer to a full payback situation. Thereafter, generally, citrus orchards are significant wealth creators allowing a twofold or more margins over variable expenses.

In the Shashe experience, trial and subsequent field crops, inter-row cropping the citrus rows (circles) has mitigated the dearth of short term liquidity but this comes at the risk of damaging the outlying peripheral rooting development of the young trees.

1. Climatic requirements

•• Shashe is ideally situated to grow citrus of top quality and at yield levels well above the National Norm. Citrus trees are subtropical in origin and are particularly suitable for dry hot summers and the coldish winters of the Limpopo River valley but cannot tolerate severe frosts. The dry climate reduces the pest challenge but of course requires that irrigation is readily available 24/7/365.

••Moisture is the most limiting factor in citrus production. Because rainfall at Shashe is often poorly distributed and in most years deficient, it is necessary to replace rainfall with irrigation to ensure that moisture stress does not suppress growth and production. The Shashe pivots and submersible pumps can supply a maximum of nearly 300 litres per tree per day for fully grown trees. It is not expected that this level of irrigation will be required for any but a few months a year; however for planning purposes it is essential that the full theoretical requirement is provided for.

2. Temperature prior to flowering

••Citrus requires shorter days and cooler temperatures in winter for a normal production rhythm.

••Flowering should occur almost exclusively in spring, and these spring flowers should produce a large fruit crop 7 to 12 months later, depending on the cultivar.

3. Soil requirements

Citrus can be grown in a wide range of soil types provided they are well drained. Fertile, well-aerated soils with a pH of between 6 and 6,5 are ideal. At Shashe the pH tends to be above 7 and this needs to be considered when developing the fertilizer program. Siting the Centre Pivots entailed including

significant areas of poor drainage and high sodic soils on which it will be difficult to manage for Citrus production for the reason explained below.

The growth, development and production of any plants depend on the physical characteristics of the soil such as drainage, density, texture, water-holding capacity, structure, soil depth, the homogeneity of the profile, erodibility, and the degree to which water can infiltrate the soil. These characteristics differ in the various soil types but generally Shashe soils are suitable with the above mentioned exceptions. Due to circumstances beyond the planners control, the exact location of the pivots had to encompass limited areas of unsuitable soils showing strong signs of salinity. The very nature of Pivot irrigation characteristically covers entire circles that sometimes have to include rocky outcrops or waterways.

A. Influence of physical soil properties on the development of citrus trees

Root development

The roots of citrus trees normally grow to a depth of 1 m, which is fairly shallow for trees, and spread to 2 m beyond the drip line of the tree.

Certain factors, such as a rock or gravel layer, a mottled clayey soil or a sandy mottled layer could, however, limit the normal spread of the roots.

If any limiting layers are found within 1 m of the soil surface, the effective soil depth for the development of plant roots will be restricted to the depth at which the upper boundary of the restrictive layer occurs which is what is happening in the Sodic areas. A greater effective depth will cause an increase in plant yield and growth, because a greater volume of soil can be exploited by the plant roots. The opposite is also true.

Root development can also be restricted by a low availability of water and nutrients.

Water supplied through rain or irrigation is absorbed by the fine particles in the soil and is then available for absorption by plant roots.

In two small areas at Shashe, oversaturation or water-logging occurs in soils that have a layer which restricts the drainage of water. Such layers can be identified by one or more of the following characteristics:

••Grey or yellowish-grey colour

••Abundant yellow-brown or reddish-brown mottles

••Soft and hardened mottles (concretions)

••Prismatic or columnar structure

••Strongly developed block structure

••Very clayey

••Stratified rock layers.

It may be possible to ameliorate the position somewhat by ridging up the tree rows, trenching drains, the application of Gypsum and Calsap (a new Australian product).

An ideal citrus soil will, in respect of optimum water provision, have the following characteristics:

••Red, yellow-brown or brown colour

••Clayey content of 10 to 40 %

••No clayey, mottled or structural layers within 1 m of the soil surface.

Generally Shashe fits these criteria.

The layout of citrus orchards depend on the irrigation infrastructure

Before planting an orchard it is advisable to provide irrigation facilities such as pipelines and a secure water delivery system. At Shashe it was decided to develop CENTRE PIVOTS and it may appear on first sighting that this is an expensive approach, however

Although the Pivot Cost approximately $2,500 per Ha in 2012 against a cost of approximately $1,800 per Ha for other alternative systems.

The pivot system ensures each tree receives its precise allocation of water regularly every cycle with the minimum of daily supervision.

B. Irrigation systems

Whether circular or grid layouts spacing between rows and trees within the row must first be examined. In the Limpopo valley Citrus trees properly cared for grow quickly and therefore high density plantings, apart from being expensive, do not really return sufficient early production before alternate trees have to be removed in five years time. Thus it was decided to set the tree spacing at 9ms by 5ms in the row. This is a slightly wider row and tree spacing than in less favourable citrus areas.

Conventional Commercial orchards in the area are supplied with irrigation water through Micro spray systems. They are not much less expensive per hectare but significantly require a high degree of supervision ensuring that each nozzle at each tree is fully operational ALL of the time. It was decided that this level of management would not be available at Shashe.

Similarly, hose and basin is still relatively expensive to set up, but in addition almost impossible to daily monitor the individual application to each tree, especially where individual farmers are unlikely to abide by regular disciplined attendance.

Conventional overhead sprayers wet the whole tree and are generally considered an inefficient application method especially if the lateral lines have to be moved each 12 hours. A single set of field irrigation overhead sprayers would be a prohibitive expensive.

Conventional Centre pivots (supplying overhead irrigation) can be adapted in two ways. Firstly the booms can be raised to what is called “an Ultra high” height above the crop. Secondly dropdown hoses secured by ridged cross bars can deliver the water below the branch and leaf line. By careful choice of the nozzle package exact delivery to each tree can be accomplished. For this reason, above all, Centre Pivots were the delivery system of choice.

The circular planting system applicable to Pivot citrus orchards is not without its critics. The following commercial farmer discussion illustrates the comprehensive nature and conflicting views involved in deciding which delivery system to use:

1. Disadvantages claimed by farmers replacing Centre Pivots with Micro Jets:
    - Pivots increased *Phytophora* incidence; severe Phytophora-like disease was evident on a few farms. So badly were trees affected that one of the farmers had replaced many trees and was well advanced replacing the pivot with Micro jets. Alternatively, Pro-Pivot Farmers claimed that they had no greater *Phytophora* disease in their Pivot orchards compared to standard irrigation methods and suggested other causes for this problem.
    - Pivots use more water particularly in the early years when inter plant areas within rows are unnecessarily watered. Apart from the extra expense of pumping redundant water, weeds are encouraged. Whereas some farmers planted additional inter row and plant crops (watermelon, butternut etc.) in the first few years it was pointed out that there is a danger of catering for the intermediate crop at the expense of the citrus orchard.
    - Inflexible design of Pivots; circles waste precious land, close to but, excluded from the circular pivot, this particularly on square and rectangular fields. This also leads on to the inability of adjacent fill-in tree areas, to line up with the circular tree plantings to enable efficient tractor operations.
    - Heavy applications of water at the periphery of the pivots cause compaction of soils; evidence of wash and root exposure were seen in some pivot peripheries. It was claimed that the larger volumes of water directed to the outside lines tended also to compact the soil encouraging

run off. To counter this, farmers had formed basins but suggested this complicated the control of root rots and might contribute to *Phytophora*.

- Roads always seem to be wet; any road not directly running to the centre of the pivot will be constantly watered as the pivot passes over it. However as the pivots cross access roads (direct to the centre) it is possible to turn the water off for a short time.
- Water forcibly sprayed directly on to stems/trunks encourages disease; Apart from possible debris and small sand particles either directly or splashing up and injuring the trunks of the trees, it was suggested that pathogens within the water could lodge in the bark. More importantly it only takes a few minutes for a set volume of water to be delivered to each tree as the pivot passes by. This can lead to "stagnant" pools of water forming while the water drains away. Other systems may only deliver the same volume of water over a very much longer period. Some farmers pointed out that perhaps this was a problem with drainage not Pivots as such. Indeed on the sandy and gravely areas this did not appear to be a problem perhaps because the infiltration rate is higher.
- Pivots planted in circles hindered even ripening and Brix counts; Planting North / South was not universally accepted as a planting direction (some farmers planted East / West to reduce sun scorch in the late afternoon) however, generally it was accepted that the principle of setting the orchard ground plan to optimise sunlight. One farmer said that he thought that the colour/ripening and Brix unevenness would be insignificant a week later in the harvest season. It was pointed out that Shashe is well north of the Tropic of Capricorn and suggested that the importance of field orientation was therefore diminished.
- Pivots planted in circles hindered labour control; undoubtedly, control over orchard tasks such as hoeing, pruning, etc. will be very much more difficult. Every farmer acknowledged this.
- Pivots are more complicated to repair than Micro jets; whereas general maintenance is simple on a pivot it is also true for Micro jets, in fact, Micro jets merely have to be uncoupled and re-joined a task unskilled labour should be able to perform without supervision. Wind and excessive growth can topple pivots, electrical drive controls often get out of line, and gearboxes do wear. Any repairs to the superstructure will certainly have to be undertaken by skilled technicians at additional expense. Adherents of pivots say that although Pivots may be more complicated they are infinitely easier to monitor as there is only one boom to inspect and maintain whereas Micro Jets have many thousands of working (or not working) parts, each to be inspected each day and unlikely to be achieved in communal circumstances.

  HOWEVER, REPAIRS TO THE PIVOT CAN BE CHALLENGING AT THE DISTANCE SHASHE IS FROM TECHNICAL ASSISTANCE. THIS ASPECT IS REALLY THE ACHILLES HEEL OF THE SHASHE SCHEME.

- Pivots planted in circles do not allow free air flow through the orchard leading to a more severe microclimate leading to greater disease and pest pressure; This aspect did not actually play out with on the ground examination.
- Tree growth has to be more carefully controlled; to ensure that the tops of trees do not hinder the passing Pivot boom arches.
- Uneven land profiles lead to uneven water distribution; these phenomena occurred were wheel tracks rose or fell following the profile of any uneven land in their path. This caused the down pipes to move in sympathy out of line to the horizontal.
- Equipment more subject to theft; reports of theft of wire, tyres and tubes in particular were mentioned. In general it was felt hat Micro Jets were less prone to theft. Any one of the above thefts could render the pivot unserviceable whereas theft of some micro jets would not necessarily disable the scheme significantly.

2. Advantages claimed by adherents of Centre Pivots

- Ease of application; there is little or no filter maintenance, algae growth is not a problem and daily maintenance minimal.
- The system is not so susceptible to casual damages; such as badzas, slashers, and animal wanderings.
- Reduced staffing; generally farmers said they needed only one attendant per pivot or so and in large estates one skilled technician can look after fifteen to twenty units (up to 700 Has.)
- Less switch-off drainage to the lowest point of the equipment; at the end of a cycle the excess water drains evenly away whereas in Micros the water drains to the lowest point and can take a long time.
- Possibility of spraying Micro elements and other pesticides using the pivot structure; coupled with solenoid timers or similar devices run from 50mm PVC attached to the spans and appropriate drop down verticals, nozzles, and foggers. Most farmers thought that it would be unlikely that spraying in this manner would be penetrative enough to be effective.
- More effective distributing water in a drought situation; it was suggested that Centre Pivot irrigation was more effective than other systems during periods of drought possibly because the application rate allows for the maximum infiltration before evaporation becomes significant.
- More certain and even distribution of water; This also applies to fertilizer distributed through the system which will also be distributed evenly where the water falls.
- Monitoring water is easier; testing discharge rates can take as little a two minutes so adjustments can be made quickly.

- Circular plantings are less prone to wind damage; Farmers said that their circular orchards withstood windstorms better than traditional straight row orchards.

C. Citrus cultivation process

1. Pre Planting

••In the case of Shashe this involved tracing the tree circles prior to ripping the planting lines by operating the Centre Pivot and thus marling the 9ms wide tree rows (Circles).

Once marked the circles were ripped to 45cms deep and the tree positions marked at 5 ms apart.

••These stakes represent the tree positions but before the plant holes are dug a planting plank must be used to maintain this position accurately.

••A planting plank is about 75cms long with two "V" notches set at the ends of the 6" broad plank. A third 'V" notch is set half way along the board. The plank is such that the centre notch surrounds the marking stake, the two other stakes are firmly set in the end notches. By removing the plank, but leaving the two end stakes, the exact position of the marking stake can be re-established once the planting hole is dug by replacing the planting plank aligned to the two outside stakes It is here that the tree stem AND root crown must be set when planting.

2. Planting

••Early spring is the best time for transplanting. Planting holes of 0,5 x 0,5 x 0,5 m are prepared and the soil mixed well with 2 spadefuls of compost or kraal manure and generally 250 g of superphosphate. However at Shashe Soil sample reports indicated there was sufficient Phosphate in the soil already, so additional phosphates were not added. The young trees are planted to the same depth as they were in the nursery i.e. level with the root crown. Keep in mind that loose soil tends to compact so care should be taken to ensure no depression will develop close to the tree stem. The bud union should be about 300 mm above the ground but this will have been prescribed by the nursery.

••The young trees are planted to the same depth as they were in the nursery i.e. level with the root crown. Keep in mind that loose soil tends to compact so care should be taken to ensure no depression will develop close to the tree stem. The bud union should be about 300 mm above the ground but this will have been prescribed by the nursery.

••Once the tree has been planted, the soil must be firmly tramped down. A basin for irrigation is made around the tree which must be thoroughly irrigated immediately after planting. Irrigate again the following day to seal any cracks in the soil.

3. Irrigating the crop

During the first 6 months the trees should be irrigated at least twice a week and thereafter at least every 7 days. The irrigation basin should be gradually enlarged as the tree grows, so that it is always slightly bigger than the drip line of the tree. Being careful not to damage the fine superficial feeder roots.

The water required depends on weather conditions. Saturated and poorly-drained conditions can result in root rot, which will shorten the life of the trees. On the other hand, a shortage of water may have the following effects:

••Moisture stress during early spring while the tree is flowering, could result in excessive drop of flowers and fruitlets, and the resulting crop will be small. A serious drought followed by good rains could produce out-of-season flowering and fruit setting.

••A lack of moisture during October to January could result in acid fruit.

Do not wait for symptoms of water stress before applying water. A tree can suffer from stress well before any visible signs appear. A slight leaf wilt is a sign of a lack of water and this must be prevented. It is then too late!!

4. Leaf sampling

Leaf samples must be taken during the middle of April period:

A leaf sample should represent parts of the orchard that are smaller than 3 ha in which the soil is homogeneous (The same). If soil variations occur, separate samples must be taken. To ensure that a good, representative sample is obtained, 3 to 4 leaves per tree from about 20 trees (60–80 leaves) should be sampled evenly through an orchard. Leaves should not be picked from the same side of the tree. Mature 5 to 7-month-old leaves are picked behind the fruit on the fruiting stem.

Important factors when sampling leaves:

••Different cultivars should be sampled separately.

••Leaf samples must only be taken from bearing trees.

••Leaves should preferably be sampled in the morning when the dew has dried off.

••Leaves must be free of sunburn, disease symptoms or insect damage.

••Leaves should be gathered in clean, new paper bags.

••The bag should be tightly sealed after sampling. If the samples cannot be delivered immediately, the bag should be kept in a refrigerator (not a freezer).

••Samples must be delivered to the laboratory for analysis within 2 days of sampling. Samples dispatched by post will not be suitable for analysis.

••Every sample must be accompanied by a completed questionnaire, as this information is important for recommendation purposes. Questionnaires are available from the Analysis Service, ITSC, Nelspruit.

••Leaf samples should be taken annually from the same trees (mark trees with paint).

Mature 5 to 7-month-old leaves behind fruit on fruiting stem are picked for leaf sampling

5. Soil analysis

••A soil-analysis report of a certain orchard can only be reliable if the soil samples which are analysed are representative of the particular orchard.

••Soil should be sampled at the same time as the leaves.

••It is important that the samples taken represent a homogeneous field or orchard.

••A soil analysis merely indicates the chemical composition of the soil; physical problems such as water-logging and plough-soles can only be determined by means of profile holes.

Method of soil sampling

If a soil auger is not available, a spade may be used.

Topsoil: 0 to 200 or 300 mm

Subsoil: 300 to 500 mm

A sample must consist of at least 10 subsamples, representing an area of not more than 3 ha. Samples from different orchards should not be combined.

Sampling points

The samples should be taken evenly by moving diagonally from the corners through the orchard. Samples should be taken under the drip area of the trees (in tree basins).

Mixing and packing

••The subsamples taken from a certain orchard should be placed in a clean container (not a fertiliser bag) and thoroughly mixed.

••A sample of about 2 kg is taken from the composite sample and put into a strong, clean plastic bag.

••Every sample must be clearly marked.

••In addition to the name of the producer, the number of the orchard, sample number and the depth at which it was taken should be indicated on the label.

••Attach the label to the outside of the container. If placed inside the container it might become illegible.

••Send the sample to the nearest soil analysis laboratory. Dept of Specialist Services Harare

6. Fertilisation

During the first year, nitrogen may be applied every 2 months. The following nitrogen fertiliser should be applied:

•• x 6 applications of 36 g ammonium sulphate (21 %) (216grms) per tree per year (one matchbox full of fertiliser is roughly 36 g).

From the second year, nitrogen must be applied twice a year +50% the total application each year until in the seventh year about 2 kgs are applied as 1+1 , half in July and half in March. Fertiliser should be spread evenly under the canopy of the tree and irrigated. Very deep irrigations will wash the fertiliser down too deeply and out of reach of the shallow feeder roots.

Phosphorus may be applied at any time of the year but at Shashe is not generally required. One application should be sufficient. Potassium should also be applied once, early in spring.

It is necessary to apply micronutrients. These elements are dissolved in water and applied as a spray onto the tree. Deficiencies of zinc, copper and manganese often occur and may be applied in 10 **l** water at the following concentrations:

••15 g zinc oxide

••20 g copper oxychloride

••20 g manganese sulphate.

The micronutrient solutions should be sprayed during early spring when the leaves are actively growing. A boron deficiency can be rectified by spreading 20 g borax per large tree under the canopy or by spraying with a solution of 10 g solubor/10 **l** water.

7. Pruning

••Citrus trees are not usually pruned, although dead wood must be removed regularly.

••To avoid low branches reaching to the ground, trees are skirted soon after the crop is removed.

••Branches reaching to the ground hamper the removal of fruit lying underneath the tree, impede irrigation and promote ant infestation of the trees.

••Branches reaching over the Pivot scaffolding must be trimmed to avoid damaging the trees and the pivot. This will also restrict the trees growth to manageable harvesting heights.

••When trees become too big and start growing into one another, pruning is recommended.

8. Control of pests, plant diseases and weeds

The use of pesticides should be restricted to a minimum. There is a balance between pests and their natural enemies. When pesticides are used injudiciously this balance is disturbed and a vicious cycle is created. The result is that these trees have to be sprayed regularly. Apart from the cost factor, this is dangerous because the fruit producer, although normally using protective equipment such as gloves, overalls or respirators, will always be affected by a certain level of contamination. IPM (Integrated Pest control) is much the best approach and this requires constant monitoring and only spraying when various threshold populations are reached.

In addition, Shashe's primary market is Beit Bridge juicing and they need to be confident that the fruit is not adulterated by chemical sprays.

9. Scouting

Scouting is a very important aspect of pest control for several good reasons, not least because it can mean the farmers can justifiably reduce their chemical bills and secondly because early warnings of oncoming pest infestation can prevent greater damage (and loss of income) by timely preventative actions, be it chemical or otherwise.

Scouting requires a thorough knowledge of the life cycles of the major pest mentioned below. The thresholds where economic damage may have been or is about to be significant has been established by various authorities are readily available.

Specialised courses are an important training tool, but largely beyond the scope of description in his brief manual. Refer to the Citrus Academy of Southern Africa

Ants

••Some of the most important insects to be controlled are the brown house ant and the pugnacious ant.

••To keep ants out of the trees, insecticides sold under various trade names can be applied around the tree trunks.

••Ant nests, particularly those of the pugnacious ant, underneath or near the trees can be treated with registered chemicals. Spray or brush Chlorodane at the rate of 4 litres per 100 litres of water on to the trunk of trees and down ant holes observed in the field.

Red scale

Red scale is controlled satisfactorily by natural enemies, provided ants are kept out of the trees (see Ants). If need be, Chloropyrifos 480 EC at the rate of 100mls per 100 litres of water as a full cover spray at 80% petal fall in spring

Soft brown scale

Soft brown scale secretes a sticky substance, known as honeydew, on the leaves and fruit. The honeydew subsequently turns black as the result of sooty mould that grows on it. Soft brown scale is controlled very well by various parasitoids and predators, provided ants are kept out of the trees (see Ants). If need be Dimethoate 40 EC at the rate of 35mls per 100 litres of water as a full cover spray when seen

Citrus thrips

Severe attacks by citrus thrips cause young shoots and leaves to become thickened and distorted. Developing apical shoots may turn black and fall off. During development the peels of young citrus fruit can also be blemished by citrus thrips. This mostly starts from the stem-end and may spread downwards extending over the rest of the fruit. However, it does not affect the eating quality of the fruit or its suitability for juicing. Generally not needed for juicing fruit or local consumption, but if need be then Pilarking 20 SC at 1.5 mls per year of tree age painted on stem, or Confidor 200 SL at 9 mls per tree around base and watered in.

Orange dog

Orange dog is frequently a problem on young trees because it feeds mainly on the young leaves. The smaller caterpillars are black with yellow and those that are larger, green and brown. They can be identified by the unpleasant smell that is exuded when touched. They can be collected by hand and destroyed. Generally not needed for juicing fruit or local consumption, but if need be then Chloropyrifos 480 EC at 40/60 mls per 100 litres of water as a light cover spray.

Citrus Psylla

Citrus Psylla is the vector and transmitter of a major citrus disease known as greening. (see Greening under Diseases). Citrus trees have 3 normal growth flushes during the year: spring growth during August/September, followed by a second in November/ December and the last during

February/March. Lemons are, however, the exception since lemon trees form new leaves throughout the year. It is during these flushes that the trees are subject to Psylla infestation. It is therefore important to examine the trees thoroughly during these periods to determine the degree of infestation and to organise control of the pest accordingly.

The female lays easily discernible orange-yellow eggs on the edges of young leaves. When the eggs hatch, the young nymphs move to the underside of the leaves where they establish themselves to feed and cause pock-like malformation of the leaves.

Control of the pest must be aimed at destroying the nymphs as soon as possible after they have hatched. Because all the eggs do not hatch simultaneously, it is essential to use a spray with a fairly long residual action. Apply Choropyrifos 480 EC at 60 mls per 100 litres of water when eggs start to hatch on new leaf

Fruit flies

Fruit flies cause post-harvest decay on fruit. The normal control method is to bait traps with a mixture of malathion and sugar in plastic bottles hung throughout the orchard, or to apply a toxic bait to the leaves of the trees. Applications must commence in February and continue up to the end of the citrus season. The important period is from February until the end of June. Bait as large droplets by flicking solution on a paint brush into the tree to settle on multiple leaves. The solution is 300 grms of Malathion 25 WP and 7.5 Kgs of Sugar per 100 litres of water.

False codling moth

Larvae of this moth feed inside the fruit and cause decay. Remove and destroy all dropped and infested fruit from the trees weekly. Also remove all out-of-season oranges in November and again once the fruit has been harvested. Infested fruit serves as a source for re-infestation. Apply Alystin 480 SC (Triflumuron) at 20mls per 100 litres of water as a single cover spray in January each year.

IT IS PARTICULARLY IMPORTANT TO SANITISE THE ORCHARD ALWAYS!

Citrus bud mite

This mite is exceptionally small and hides in the flower and axillary buds. It causes malformed growth points, flowers and fruit and also peculiarly shaped leaves. The growth of young trees is seriously hampered and yields can be reduced dramatically. Young citrus trees up to the age of 10 years MUST be sprayed once a year to control this pest. Apply Abamectin at 20 mls per 100 litres of water with 300 mls of mineral oil. Apply early spring when flowering complete and scouting thresholds indicate presence.

Weeds

It is very important to keep the area under the canopy free of weeds. Nutgrass and quickgrass, especially, should not be tolerated. Weeds may be removed by hand. Be careful not to damage the shallow feeder roots or the trunk when spades or other tools are used. Wounds promote penetration of soil pathogens which cause root rot. Weeds also act as pathways for ants. Hand cultivating light weed infestations is best. Weeds out of control are a complete waste of fertilizer water and the completion will hold citrus trees back significantly. There can be NO EXCUSE of weeds in allocated plots. However in the event paraquat (a Desiccant) or Glyphosate (Trans-located to roots) may be needed, sprayed at about 3-7 litres per Hectare dependant on the height of the target weeds.

Hand cultivated weeds should be mulched round the tree drip-line but not against the tree stem.

NOTE: CROP RESIDUES FROM THE INTER-ROW CROPPING SHOULD ALSO BE MULCHED ROUND THE TREE TO PROVIDE SHADE AND ORGANIC MATERIAL TO THE TREE ROOTS PRESERVING MOISTURE AND ENCOURAGING PREDATORS OF PEST TO THRIVE.

10. Diseases

Citrus black spot

This disease is less common and can be controlled effectively with chemical remedies. It really only affects fruit destined for export but if scouting confirms its presence then it should be erabicated immediately to prevent spread. Spray mancozeb 75 WP at 180 Grms per 100litres of water three times at 25 day intervals beginning 3rd week in October each year.

Scab

Scab often occurs on rough lemon seedlings. The symptoms are a corky roughness on the leaves and young twigs. It can be controlled chemically. Spray Copper Oxychloride at the rate of 200Grms per 100 litres water after petal-drop.

Greening

Greening is not expected in Shashe however it is advisable to be aware of the symptoms

It is an important disease which is prevalent in the relatively cooler, high-lying areas (above 600 m). Typical symptoms are yellowing of the leaves and malformed fruit. One side of the fruit along the central axis does not develop normally and remains smaller, resulting in asymmetrical fruit. The smaller side remains greenish while the rest of the fruit turns orange. The disease is caused by a bacterium for which no chemical treatment is available. It is transmitted by psylla (see Citrus psylla).

As greening is usually localised within one or two branches of the tree, it is advisable to cut out such branches. Saw them off as close to the trunk as possible. If the entire tree is affected, it would be better to removed, burnt and replace it.

Phytophthora

Phytophthora is a water mould that is found throughout the world. Under favourable conditions (high moisture and temperature) it produces large numbers of motile zoospores that can swim in water for short distances. These zoospores are the infective agents that may be transported in rain or irrigation to the roots. When zoospores contact roots they encyst, germinate and enter the root tip resulting in rot of the entire rootlet.

Foot rot or gummosis occur when zoospores splash onto a wound or bark crack around the base of the trunk.

SYMPTOMS Leaf - yellow foliage and shoot die-back. If citrus weevils are present adults may feed on leaves causing notching. Fruit - reduced fruit size and yield. Trunk - infection of the trunk by *Phytophthora* results in dark water soaked areas in the area of active infection. Lesions usually occur on the bark or at the bud union. Lesions may exude copious amount of gum and a brown necrotic area will be found under the bark lesions. Dead bark tends to break away from the trunk in vertical strips. Lesions may spread around the circumference of the trunk slowly girdling the tree.

Whole tree - *Phytophthora* may result in poor tree health, thin canopy, failure to make new growth, and little water and nutrient uptake leading to wilting. When roots are infected the surface of the root becomes soft, discoloured and appears water-soaked. Fibrous roots slough their cortex leaving only the white thread-like root cylinder. Phosguard 40 SL at 250mls per 1 (one) litre of water may be painted on to the truck of the tree.

5. Conclusions and Considerations

We have shown that the conventional models of managing communal land irrigation schemes generally fail due to four principal institutional weaknesses. Such schemes

- Lack the financial resources to sustain themselves in regard to repairs and maintenance, salaries and wages for permanent employees, and replacement of obsolete machinery, pumps and tools.
- Lack the institutional capacity to cope with the day to day management and planning required for effectively running schemes in common property regimes.
- Lack sustainable and viable markets for their produce
- Due to a lack of capacity of governmental extension agencies such as AGRITEX to service such schemes, farmers are not able to keep abreast of innovations in agronomy and irrigation.

At Shashe, by using Systems Thinking, a series of preliminary workshops and focus group sessions were conducted. The weaknesses above were identified as relevant. Using the methodology of Scenario Modelling a new model was developed. This included integrated features that create a symbiotic system for a sustainable governance and management of the scheme while providing a profit incentive to farmer beneficiaries and their families. Through adaptive management techniques the new model was gradually introduced over a five year period and culminated in its two major components.

1. In the institutional arena a functional IMC eventually developed into a community trust with attendant organisational structure serving the institutional needs of the community.
2. On the technological front, eight boreholes with submersible pumps now provide water to three centre pivots in sufficient quantity to irrigate the 22500 orange trees planted over three successive seasons. Concurrently inter cropping between the citrus was introduced. Cultivation of maize, seed beans, sweet potatoes, cabbage and cucurbits are now regular feature. Contract farming of high value crops is on-going and the scheme is beginning to earn money with which to maintain its staff, buy seed and fertilizer on behalf of its members, and start taking over the costs of energy and repairs and maintenance. Within the next two years it should be financially independent.

As described in earlier chapters, the Shashe Scheme rests on:

- the integrated development of a resilient and autonomous management institution able to insure the tenure rights of its members
- the introduction of appropriate, efficient and effective new technologies to maximise irrigation water resources and farmer profitability.
- the involvement of private sector partners of proven professional integrity.

- The introduction of a inter-row cropping regime to guarantee food security and maximise profits by growing high value crops based on best farming practise, supported by private extension services until such time as AGRITEX's capacity to fulfil its historical role is restored through extensive capacity building.
- establishing synergies and partnerships with the private (commercial) sector and the research community
- and by ensuring dependable and viable markets for all and any commercial crops grown on the scheme.

It has to be stressed that the growth and strength of such a model cannot be achieved in one or two years – certainly not on comparatively large schemes, and certainly not on a pilot project. Shashe has shown that the process is iterative and subject to surges of progress, followed by set backs and reversals which can usually be identified with engineering and installation (such as commissioning of a centre pivot and its consequential increase in management responsibilities as well as expectations.) A clear pattern of institutional capacity through learning follows in the light of new problems and scale of management as a result of expansion. Governance and management must obviously learn to cope with and devise ways of allocating resources, of bringing the beneficiary farmers (especially the older, and the more cautious and conservative members) to understand and accept in practise what they have previously only thought of conceptually.

The increased dimensions and scale of operations takes time to be fully understood, both in regard to time (cycles of development and production), input of labour and of costs. Potential risks and survival/sustainability have to be assessed and decisions reached. Most important of all, the farmers both as individuals and as members of a community have to decide on the best options to adopt or reject. In the final analysis, it is their decisions that drive the process to success or failure – either by enthusiastic involvement or by passive indifference; or as has been our experience by generally displaying a typically cautious approach. There is noticeable reliance on local wisdom and careful observation of the more enterprising and sophisticated to test and validate new technology and concepts. Humbling for facilitators and technical experts, has been this influence of local knowledge and experience in leading the more resistant and conservative members towards acceptance of change. A division between young and old, between males and females and between outsiders and insiders form part of the mosaic that informs the process of change.

What we have called adaptive management is a method of managing the ever increasing pace of change. It involves constant, iterative self assessment by the community, guided by empathic facilitators and mentors. It involves, a resilient and committed partnership consisting of a core community organisation (the IMC) supported and assisted by resource personnel – partners from the

Private, the Public and Academic sectors. All of the latter must be philosophically and demonstrably engaged in a supportive and not authoritarian capacity. They must not be allowed to impose their own agendas and perceptions upon the growing institutional capacity of the community. Yet this they must balance against the constraints of time, project infrastructure development, sudden and unexpected events : natural (floods, droughts); and technical and logistical; delays caused by budget and financial regulations designed for northern hemispherical seasons, not Southern Africa's climatic imperatives; by human fallibility and fatigue; and perhaps most of all, suspicion and scepticism rooted in differences in cultural and customary perceptions, priorities, obligations and constraints.

Best practise in project management is the ability, integrity, resilience, patience and vision to balance the complexity of such an undertaking. In the case of the Shashe Experiment it is instructive to list the lessons learnt and thus provide a framework to acknowledge weaknesses and highlight the strengths. Indeed a post project modified SWOT analysis provides a useful tool in this regard.

Strengths:

1. Adaptive Management:

The methodology of "adaptive management", has the advantage of being flexible in the approach to goal identification and setting. It is more in line with rural peasant realities than hard wired and less flexible methods of project management as applied in commercial and industrial institutions.

2. Demonstration Plot and Training Centre:

The introduction of new ideas and technologies is enhanced by demonstration and precept. Thus the idea of a demonstration plot was critical in confirming the objective of installing centre pivots for irrigating citrus. It also provided a venue for experimentation with intercropping between the trees and allowed local ideas to be embraced as well as more "exotic". Thus crops such as rape, sweet potatoes, cabbages and bean were grown as well as new crops such as butter nut and oriental leaf crops. Experiments in growing crops for their sale as seed to Agri-business seed companies were undertaken. New varieties of heat tolerant maize were and are being tried. The demonstration plot developed fast into a focal point for the farmers. So much so that all meetings (both formal and informal) are now held at the small resource centre adjacent to the "demo plot" The name "Demo" has entered into the vocabulary of the community. It is uniquely theirs but is the venue where all partners share a common bond of interest in the scheme. It is without doubt the single most important hardware aid to the general progress made at Shashe. Visitors from neighbouring schemes (and even from over the border in Botswana) are also made welcome and ordinary scheme members may be observed showing such people around and explaining the virtues and hurdles implicit in their efforts.

3. Centre Pivots:

Whilst the majority of community members at workshops and at general and informal meetings were in favour of introducing pivots they had little if any practical knowledge in this regard. As mentioned above, even the demonstration pivot (2.5 ha) was not enough to prepare them for the sheer size of the area encompassed by a single pivot, let alone three. It must be remembered that prior to the current programme, while the theoretical size of the scheme was 184 hectares, for as long as twenty five to thirty years, no more than 20 ha and often less had been under irrigated crops. Many farmers had only their parents' memories of the scheme when it was in full operation with all the attendant work and commitment that this entailed. It is a sign of positive commitment, and thus a strength displayed by the farmers, that with the exception of a small minority, the IMC and local leaders were able to convince their constituents of the added value the pivots would bring to the scheme. A further competitive advantage was the enthusiasm and involvement of the Beit Bridge RDC 's CEO (Albert Mbedzi) who himself had grown up on SIS . This in turn enhanced the commitment of his community affairs officer Mr Peter Ncube, also with strong traditional and local connections, who is a skilled facilitator and trainer. Once operating, the advantages of the pivots have become apparent. No more is their competition at field level for the supply of water. All areas under the pivots receive approximately the same amount of water. There are savings of water over the less efficient system of flood irrigation previously practised.

4. Submersible Pumps and delivery systems

Irrigation is by definition the application of water to land otherwise deficient in this essential ingredient, for the production of crops in arid areas. The prime cause of failure of schemes in Zimbabwe has been the break down in such supply due to old and redundant pumps and delivery pipes, and the cost of over heads such as maintenance and electricity. By engaging a qualified and vastly experienced irrigation engineer, Cesvi and the community were able to avail themselves of the best solutions for water provision. This entailed an element of risk in that the sinking of "boreholes" in the sand of the river bed and fitting them with submersible pumps had not previously been attempted at Shashe. The success of the technology has proved itself, though lateral pipes from the pumps in the river bed to the point where they join the main delivery lines on the river bank can be a hazard in serious floods. The installed system (which was introduced incrementally in harmony with land clearance and the purchase of young citrus trees) has proved a very positive strength for the scheme. When available, water has been supplied to the parallel efforts by the community to revive Blocks A and B (with sporadic support from SAFIRE) using old extant and renovated in-field canals. However, this will not be possible when all three pivots are operating and the grown out trees demand their full calculated water requirements.

5. Citrus and inter-cropping

In order for the areas of the scheme (old blocks C and D) to be made fit for planting extensive bush clearing had to be undertaken. This was a slow and laborious task and tested the community's commitment and resilience to the limit. Only when this task was completed on the section assigned to Pivot One could the pivot be installed and the land holed out for planting. This huge task affected the anticipated timelines for planting and completion of the scheme, as well as growth of related governance capacity. Over two successive seasons two pivots were installed and planted. A total of 15 000 trees were successfully established. The community received some assistance from WFP who distributed "cash for assets" and food packs. Trees have thrived despite some problems related to farmers attending to their holdings. (See below under Weaknesses). From the outset the farmers were anxious to grow suitable crops between the citrus lines. This was resisted by the agricultural agronomists as they considered the crops would compete with the trees to the latter's detriment. Trials on the demo plot and further research reversed this decision and bowing to local knowledge, intercropping was introduced. This has proved a great success and may well be the salvation of the scheme as it injects much needed cash while waiting for the citrus to mature (five years). A third pivot (P3) has taken the longest time to clear. The bush was much more established, competition for volunteer labour and general project fatigue have contributed to poor turn outs. The lack of further support from WFP has without doubt also contributed to the reluctance of farmers to give freely of their time and labour. (See "weaknesses" below).

Irrigation Manager:

Selection and appointment of a suitable and well qualified project on-site manager is critical. In this the project was fortunate. The irrigation project manager played a pivotal role not only in the construction phase but in building trust, monitoring and facilitating the change process and reporting on trends and possible obstacles. Such a person must be a versatile executive officer with specialist qualifications in appropriate agronomic areas (in this case citrus in particular) as well as a hands-on understanding of irrigation and machinery – in other words he must have the attributes of a general farm manager. In addition he must have an empathic feel for Human Resource management and, natural or acquired skills in capacity enhancement and community development methods. In all these areas the scheme was fortunate in the selection of the current incumbent. It cannot be stressed too highly that the utmost care must be exercised in selection, trial and mentoring of anyone for such a crucial position.

6. Local traditional leadership participation

The involvement of local leadership is an essential element in the holistic systems approach to scheme management. The failure amongst some NGOs, international organisations, and even local techno bureaucrats to fully appreciate the traditional structure and function of rural society often leads to mixed signals and confusion and a consequent diminution of trust and positive energy. From the pre inception stage at Shashe it was a matter of priority to observe traditional protocols and current practicalities. The traditional leadership has thus been engaged from the pre-inception phase up to the final formation of the trust. At regular intervals, or when the community institutional capacity has faltered or strayed, it has been the senior headman who has taken positive steps to assist, inspire and guide the community "back on track". Two members of the IMC (the current chairman is one) are local village heads or their deputies. One other is related to the local senior village head. In this way is traditional protocol through positive sanction and involvement in decision making enhanced, while in no way eroding the representative, constituent responsibilities of the elected committee. All members of the committee were elected in open forum witnessed by this writer. Thus in this way, local acumen and pragmatism has ensured a truly representative body – and one that has the popular sanction of the wider community of which it is a part.

7. Role of Central and Local Government

As important as the traditional institutions' involvement, is that of central and local government institutions and their representative personnel. Thus, again as an exercise in best practise and for reasons of pragmatic necessity and protocol, it was strategically and philosophically essential for the success of the scheme that the techno bureaucrats be active participants and partners in the progress and development of the scheme. The role of the DA is pivotal. He is the senior government executive representative and is responsible for good government in the communal areas. The DA is the link between central and local government and traditional governance structures and is the coordinator of all government ministries and departments in his district. He chairs the district development co-ordinating committee - a body consisting of central government departmental district heads, the CEO and senior officers of the RDC and the chairmen of relevant council committees; and finally, by invitation, representatives of NGO's active in his district. His too, is the task of ensuring the satisfactory functioning of the rural district council. Should the latter falter or for what ever reason become dysfunctional he has the duty and power to intervene in the cause of good governance.

From the pre inception phase and throughout the life of the project regular report back meetings have been held with the DA or his 2 1/c. At these meetings ideas are shared, problems freely discussed and assistance requested or offered. On most occasions these meetings have been joined by the council CEO who shares many of the same responsibilities, and through his council staff is the responsible

authority and monitoring agent in all rural development schemes. Indeed protocols insist that any NGO operating within a district must have formal MoU with the RDC. The need for regular and open discussion, quite apart from formal workshops and focus group discussions with staff members, is amongst the most, if not the most, critical requirement of project management. We were fortunate in the persons filling the posts of DA and CEO, both of whom have vision and determination to encourage the growth, resilience and self reliance of the rural communities within their remit. In very large measure, therefore it can be stated that their interest, direction, advice and sometimes intervention has been a major contribution to the schemes success.

An examination of the strengths and positive aspects of the project would be unbalanced without a similar analysis and comment on weaknesses, mistakes and gaps in the overall programme. These are listed and described below under the general heading of weaknesses:

Weaknesses:

1. Lack of training and capacity enhancement funds

Beyond doubt the biggest flaw in the design of this programme must be the incomprehensible lack of any significant funding for a core requirement i.e. capacity building in such an innovative approach, and for research and systematic analysis and recording of what in effect is a paradigm shifting successional experiment. This led to the following gaps/flaws/shortcomings in the programme:

- Insufficient funds to employ a fulltime "community development specialist" to work under the irrigation manager thus giving greater depth to and cascading of knowledge and learning opportunities downwards to the beneficiary farmers; and the flow of local knowledge and concerns upwards to the IMC and facilitators. Without this, the progress of effecting change in attitudes and developing a fuller acceptance of the rewards and benefits of participation, and the risks and threats accompanying resistance was noticeable.
- AGRITEX lacked capacity to give its full support to the project. The necessary and specialised knowledge of citrus and modern technologies of pivot irrigation were lacking. No funds were available to assist with their logistical inadequacies so visits by senior staff from District and Province were restricted to occasions when lifts could be scrounged. A tension developed between NGO staff on the ground and their counterparts in AGRITEX due to a possible perception that they were being sidelined. This had a negative impact.
- Insufficient funding meant that workshops and look and learn visits had to be kept to a bare minimum. A new strategy of using all meetings, especially routine IMC meetings, as venues for exchange of ideas and for ongoing scenario modelling and planning were devised. This in

fact became a positive opportunity as sub committees were encouraged to attend and in this way the reach down to farmer level was improved. Nevertheless the capacity of resource personnel to reach down to the level of small farmer groups and individuals was hampered. A method of "walk about" forays by the writer and the local project manager was rewarding but insufficient to establish lasting impact as time and follow up were never sufficient.

2. Relative Short Duration of Programme

A programme such as envisaged at Shashe is by its very nature a longitudinal project. The designers were fortunate in being able to attract funding from the EU covering a five year period. Academic and empirical data suggested from the start that while this was a brave and admirable investment by the EU, the time frame was too short. Citrus which forms the major economic backbone of the scheme takes at least five years from date of planting the young trees, before a meaningful positive cash flow can be derived from the fruit. Add to this that trees from nurseries only become available one full year after orders are placed, that land has to be prepared and irrigation water brought on site before planting can be considered, a minimum period of support for the scheme would be seven to ten years. This requires a large investment and donors argue that the cost benefit is restricted to too few beneficiaries. While this perception is challenged by researchers who argue that the trickle down effect is substantial, hard research employing recently designed tools has yet to settle the issue. Thus it has to be acknowledged that a weakness or flaw in the design and implementation for schemes using this model is the risk of support being withdrawn before the target community and its resources have reached sufficient maturity to sustain the momentum induced by the intervention.

3. Budget and financial regulation

While no blame can be attributed to the way in which funds were budgeted and financial controls implemented, it is obvious that in the management of a programme which is agricultural and thus subject to natural and season cyclical demands, a budget based on the calendar attached to annual, quarterly and monthly measurement will be out of sequence with events happening on the ground. Without a degree of autonomy and flexibility funds are sometimes not spent to maximum effect. Inevitable delays can cause serious problems when planting deadlines or water provision is threatened by unforeseen breakdowns or delays in receipt of ordered equipment. Programmes undertaken in remote areas are subject and vulnerable to "surprise" situations. Flexibility and imaginative innovation is the only remedy – attributes that are lacking in highly centralised and remote corporations or bureaucracies. Planners may or may not be able to overcome such shortcomings, but the risks to project success are without doubt heightened by this common phenomenon. Shashe by forming a net work of private sector partners, in particular Nottingham Estate, was able to turn calamity into success

on a number of occasions. Without this support and empathy from a neighbouring commercial citrus estate, one wonders if outcomes would have been as successful as has been the case.

4. Unilateral unforeseen intervention

At the start of the Shashe project, a major set back was the unannounced and unplanned entry to the scheme of another NGO, sanctioned by the RDC but without any prior warning to Cesvi. This was an understandable response to the community's stated objective of ensuring food security, avoiding putting all their eggs in one mono-cultural basket and allowing for individual farmers to grow crops more suited to their traditional practises using flood irrigation. Canals would be repaired with farmer support. Water would be supplied by repairs to old pumps and well points. In a sense it was an attempt to get the best of both worlds and the plan was in accordance with the new paradigm discussed in earlier sections of this manual. Blocks A and B would be reserved for line crops with an emphasis on self provisioning: the remainder of the scheme would go the route of commercial farming. The idea was sound, the execution to date disappointing; and the fault must lie squarely with the RDC who effectively failed to bring the stakeholders together and coordinate activities.

The capacity and resources to plan and execute a renovation programme of this scale and magnitude was lacking. Five years of sporadic and fruitless effort, worsened by series of disastrous weather induced events of serious magnitude (twice causing flooding and damage to repaired canals, breaks in a protecting barrage etc.) have left the two blocks, totalling over a hundred hectares, without sufficient water, canals or crops. At time of writing (January 2016) no crops are being grown.

To catalogue the errors of commission and omission would not be appropriate in this document. Suffice to say that the outcome is that only half the potential of the Shashe Irrigation Scheme is currently realised. What can be said, though, is that the community's efforts on Block A and B have had a serious effect on the attitudes of some farmers, and on the energy of all. Small wonder that turn out on P3 has been less than enthusiastic when persistent calls for help with fixing barrages, digging up well points in the river and helping with canal construction – all for no tangible benefit – have sapped what little energy people have left in the face of the hottest summer in living memory. (The ambient temperature on one day was recorded as over 50 degrees in the shade and was regularly over the 45 degree mark.) The future of Blocks A and B is a problem and one the newly formed trust is going to have to face and resolve, especially as a centre pivot for Block A has been delivered through the Brazilian Initiative thus bringing a third player into the arena. When the costs of running the scheme fall squarely on the farmers they will not be able to afford inefficiencies and lack of productivity from an asset as valuable as 100 potential hectares under irrigation. It is without doubt

the most serious threat facing the Shashe Scheme. At one stage, only energetic intervention by the RDC facilitator assisted by an external consultant averted a disastrous split in the community.

5. External private sector partners

On the sincerity and commitment of private sector partners rests much of the strength of the model introduced. While this was an undoubted strength in the Shashe Experiment, it would be irresponsible to ignore one salient weakness in execution of project development. That is the lack of a positive effort to include the main partners in the process of necessary change. It is as important to remember that partners with perceptions as disconnected as those being thrust together in a joint venture could not be greater. From time to time, a wide divergence of worldviews created frustration on the one hand and suspicion and distrust on the other. In any proposed programme seeking to replicate the Shashe model, the engagement of private sector partners in appropriately facilitated orientation into the culture and perceptions of communities living in common property regimes must be considered.