

Renewing Irrigation Assets



**A Report for Malawi Fruits
Funded by Comic Relief
July 2016**

1. Executive Summary

1.1 Background

Malawi Fruits is a growing NGO with a vision to bring about change in Northern Malawi through the development of sustainable business. The main industries in Malawi are tourism and agriculture: Malawi Fruits has some work in the tourism sector and is increasingly working to support smallholder farmers to develop their farms as sustainable businesses.

1.2 This Feasibility Study

This Study was funded by Comic Relief's *Generating Ideas* fund and is aimed at identifying the potential to refurbish and extend irrigation schemes on smallholder farmers' land and to explore the long term sustainability of such a project. Although this is a technical report exploring topography, water & soil analysis and full costings, it is in fact about people. Irrigated land has the power to bring about transformational change for smallholder farmers and the impact of this intervention is also explored here.

The Study was conducted by a team led by Atusaye Kayuni, Malawi Fruit's Development Executive. The team included staff from the Malawi Government Irrigation Department; the Government Laboratories; and Nyika Food Trust which is Malawi Fruit's partner in country.

1.2 The irrigation schemes

Eleven irrigation schemes were examined, all in Rumphi District in the North of Malawi. The schemes had been identified through Malawi Fruits existing work in the area and in consultation with the Government Irrigation Department. The schemes were chosen for their unfulfilled potential and the Study has examined and addressed the reasons for failure and the remedial measures needed to turn the situation around.

1.3 Options appraisal

There were no insurmountable flaws to the schemes and all were found to have potential for refurbishment and reinstatement. In all cases, poor design and/or poor workmanship were significant factors in their failure. Any future intervention would have to be tightly managed to ensure that budgets are adhered to and plans on paper are delivered on the ground.



Three schemes had diesel pumps which are now broken and obsolete: solar pumps are the recognized solution for irrigation with their high initial cost being offset by very low running costs.

While it is feasible to refurbish the structural components, the Study has also identified that this will not be enough without providing support for farmer training, maintenance, and management of the schemes. Farmers will also need initial assistance with farm inputs and ongoing support to find reliable markets for crops. The Study also recognizes mechanisation as a route to higher incomes and much improved quality of life. The concept of a Service Centre – a facilities management approach – emerges as a good option and this would point to a rehabilitation project taking in at least 75% of the schemes to make this approach viable and realise the considerable benefits.

So the key questions are, “Does it make economic sense? Is there value for money in these proposals?”

During the study there was an opportunity to speak with Christian Aid who have been installing two solar irrigation schemes from scratch in the South of Malawi. Each scheme is between 4 and 5 hectares and the cost was £45,000 per scheme giving a cost per hectare of £10,000. For the 8 gravity fed schemes in this proposal the average costs will be £1903 per hectare and for the solar pumped schemes it is £2603 per hectare suggesting that refurbishing these schemes offers exceptional value for money.

1.4 The next steps

Implementing this project will need considerable funds in the region of £600,000. Detailed costings are provided in this Study and it is recommended that Malawi Fruits pursue all available funding opportunities with a view to implementing the project as soon as is practicable. If a stepped implementation is envisaged, then work to the 8 non-pumped schemes would be feasible as a first phase (£295,000 and 155 hectares) and this would be of sufficient scale to enable the Service Centre to be established. The 3 pumped systems could then follow as a second phase (£315,000 and 121 hectares).

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2. Introduction

2.1 The Malawian economy

Malawi is a small and landlocked country, bordering Zambia, Tanzania and Mozambique. The country is defined as low-income and ranks 174 out of 187 countries in the 2013 Human Development Index, where it has stagnated for the last five years.³ More than 80 percent of Malawians are smallholder farmers with access to an average 0.23 ha of arable land, compared with the sub-Saharan African average of 0.40 ha. Female-headed households experience higher poverty than those headed by men, which is compounded by only half of girls aged 15-24 in Malawi being literate.

A period of rapid economic growth has been tempered by stagnation in the global economy and the liberalisation of the Malawi Kwacha, ending a fixed exchange rate in place until 2012 (a key point in the recent economic situation). Until 2012, the Kwacha was pegged at \$1 = MK150 and was maintained in an effort to ensure key imports (in particular, fertiliser and fuel) were affordable for a competitive economy; while exports were considered relatively inelastic, and unable to respond to any competitive advantage through devaluation. When this policy became impossible to continue, the Kwacha devalued and (notwithstanding a strengthening during the Malawi tobacco season of 2014) sits at around \$1 = 630 (2016). GDP growth in 2013/14 stood at 6.1%, recovering from its declining growth from its peak in 2007/08.

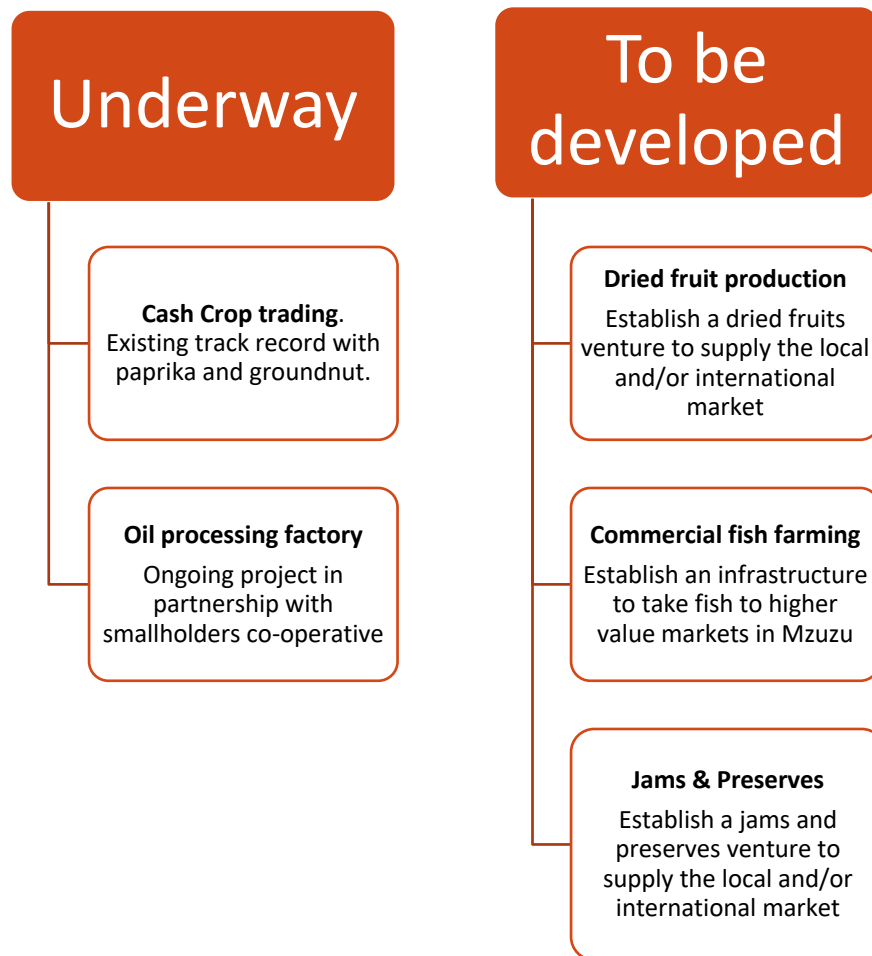
Malawi's economy remains predominantly agricultural by labour force (almost 90%), and it contributes over one third of GDP. It generates around 90% of Malawi's foreign exchange earnings from cash crop exports. The main export crops are tobacco, sugar, tea, and cotton. Maize is the principal subsistence crop. Groundnut, once a vast Malawi export commodity, is now exported in relatively low volumes, though there is further potential if aflatoxin controls can be achieved.

Agricultural production is largely dependent on rainfall, as capital intensive irrigation is out of reach for most farmers. There is very little mechanisation; the hand hoe remains the smallholder's main farm tool, meaning that productivity per worker and by hectare is low. High productivity gains are achievable - Malawi is yet to go through its Green Revolution in agriculture.



2.2 Background

This feasibility study assesses and describes the feasibility of Malawi Fruits renovating, extending and supporting irrigation schemes in the Rumphu region of Northern Malawi. Although irrigation principally supports food security and helps grow farmer incomes, it also relates to the current activities of Malawi Fruits and the future vision:



The feasibility study is consistent with Malawi Fruits' core vision which is to support and grow businesses (smallholder farms) and to develop sustainable social enterprises that succeed in finding a market for existing, and increased production of, crops.

3 About Malawi Fruits and Nyika Food Trust

Malawi Fruits is a Scottish charity with a focus on sustainable economic development using social enterprise models as a means of initiating and operating commercial operations in crop growing and processing in Northern Malawi. All operations are on a not-for-profit basis.

Malawi Fruits has until now provided start up finance, training and support to local farmers and community enterprises to enable them to secure their futures. For farmers this means providing them with a household income which can then be used for school fees, health care, etc.; for community businesses this means enabling them to be profitable with the clear agreement that all profits will be invested in further community enterprise, orphan care programmes or other charitable ventures.

In July 2015, Malawi Fruits recruited a Development Executive to work from its Mzuzu office. Atusaye Kayuni has joined from Livingstonia University where he headed up the IT department and was responsible for business innovations in the area. He researches business opportunities and represents Malawi Fruits in the country as well as providing support to Nyika Food Trust who share the office.

In September 2015 Kevin Simpson joined the staff as part-time Executive Director, based in Scotland. Previously Kevin worked as Head of Scotland with MAF and has started and run two businesses. Kevin has entrepreneurial and business management skills plus a thorough understanding of charity governance and international development issues.

3.1 Malawi Fruits Directors

Four of the Directors have led teams of volunteers to Malawi, have built strong networks there and have a good knowledge of the country. In the last 12 months there has been intentional capacity building on the Board with the appointment of Lorimer Gray as Chair and Charles Howie as a Consultant. The Directors meet every two months with Vision Days for activity planning and strategy.

Lorimer Gray	Chair	Lorimer was the founding CEO of Abernethy Trust, Scotland's leading outdoor education provider. He has vast charity and governance experience and has travelled widely through his involvement with Christian Camping International. Since retiring after 40 years at the helm of Abernethy, Lorimer has been Chair of More than Gold and serves as a trustee of SU Scotland.
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Alan Laverock	Treasurer	Retired partner in an accountancy firm. Alan specialised in charity accounting and has vast experience of SME accounting and auditing. Alan spends four months each year in Malawi.
Eric Wagner	Director	The owner/manager of a commercial science lab. He manages a staff team and has skills in production and quality control.
Jordan McKellar	Director	An award winning entrepreneur with Probetest Technologies. He has a strong sales background and manages all aspects of his business.
Russell Crawford	Director	Manages a scaffolding company in Edinburgh. HR and sales are his specialisms as well as the cut and thrust of business management in a highly competitive industry.
Charles Howie	Consultant	Charles is a Visiting Fellow at the Royal Agriculture University in Cirencester and has vast horticultural and teaching experience gained in Asia and Africa. He serves Malawi Fruits as a Consultant and Critical Friend.

3.2 Nyika Food Trust

Nyika Food Trust is a charitable organisation based in Mzuzu and registered with the tax authorities in Malawi. Its activities have been central to date to improving livelihoods in partnership with Malawi Fruits through the Paprika Project and the two organisations are well-placed to renovate and support the irrigation schemes. Again, there has been deliberate and intentional capacity building on the Board through training and support offered by Malawi Fruits and through the recruitment of new Trustees with appropriate skills and experience for the next stage of development.

3.2.1 The current Board

Rev Levi Nyondo	Chair	General Secretary of the CCAP (National Church). CCAP runs schools and hospitals and provides a wide range of services. Levi has vast experience of working with International Development NGOs and grant requirements.
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Mr. Muamba	Vice Chair	A farmer with a large area of land and a great understanding of the challenges facing smallholder farmers in Malawi.
Arnold Shaba	Board Member	Entrepreneur and businessman operating in the tourism and agriculture sectors. He has experience of HR and managing large budgets.
Ethel Piri	Board Member	Ethel is involved with several other NGOs and is a very experienced Board Member. She brings a particular emphasis on children and women's issues.
Mr. T. Mpezeni	Board Member	Tinkho is the Chief Irrigation Officer in Rumphi District and as such is a great addition to the NFT Board. Any development of irrigated land must be done in partnership with the Malawi Government department.
Mr. S. Chirambo	Board Member	Sigman is a retired farmer and qualified horticulturalist. He has served on the Board since its inception.
Mr. D. Mweso	Board Member	Dyson is an accountant and entrepreneur operating a growing and successful business in Mzuzu.

The Board and Management Committee have the required skills and experience to run large scale projects and be responsible for funds received from overseas but also receive ongoing support and capacity building advice from Malawi Fruits. In July 2016 NFT appointed Andrew Namakoma as part-time Principal Officer and Andrew comes with huge experience working with smallholder farmers. Most recently he has headed up projects tackling child labour in farming and has developed training for farmers aimed at developing smallholder farms as businesses.

Nyika Food Trust (NFT) is in the process of becoming a registered NGO with four Malawian trustees. There is a problem with the current Malawian Government's attitude to new NGOs which is holding up this process but permission to operate exists and NFT is registered with the Malawi tax authorities as an employer. Day to day matters are handled by the Management Committee which is appointed by the Board and this committee meets bi-monthly. Decisions are made based on reports and papers submitted to them by the committee members with responsibility and generally they are able to reach a consensus. Where necessary, decisions can go to a vote.

4 MF and NFT Activities to date

Malawi Fruits and NFT have worked together for three years to grow and sell paprika in the Rumphi area adjacent to the proposed irrigation schemes. This has enabled the development of a strong working relationship between each other and with local communities and a keen understanding of potential in the region for growing fruits and other crops under irrigation, and to test market demand.

NFT has worked closely with traditional authorities in the area during this period. This has established a track record with leaders, and in paprika production the traditional authorities identify the poorest households who are still able to actively produce and benefit from the crop.

4.1 Malawi Fruits' strategy

Malawi Fruits has a vision for a three stage approach to raising the income of smallholder farmers:

1. Support farmers to grow cash crops (already in place with the Scottish Government-funded Paprika Project)
2. Irrigate land to allow for multi-cropping (the subject of this study)
3. Add value to crops through agri-processing (Malawi Fruits has begun this work supporting a Farmers' Co-operative with a sunflower oil plant.)

Each step in this process raises farmers' incomes and contributes directly to bringing change in their lives and the lives of their families.

Malawi Fruits has identified the high rate of post-harvest loss of sales, and low prices of crops due to poor access to markets. This presents an opportunity to develop smallholder farm trading and processing of crops at prices which benefit farmers' incomes, and then stimulate production according to demand.

An oil seed business plan is already under development with the Malawi Fruits staff and board and other crop processing businesses will be developed in the longer term. There are several drivers behind the plan to increase irrigated land: food security is a major component but increased farm incomes through multi cropping is also a significant factor. In terms of Malawi Fruits long term vision however, the ability to source crops in and out of season for processing is a huge advantage which will make crop processing social enterprises viable for the benefit of the farmers.

4.2 Opportunities

Malawi Fruits in partnership with NFT already has a track record in growing paprika peppers and groundnut in Rumphi district. The opportunities for further development into other cash crops especially under contract and for seed multiplication or crop processing are as follows:

Availability of fruits	<p>There is an already abundant supply of fruits (particularly mangoes, bananas and pineapples), much of which remains unsold due to the lack of a local market and packaging and transportation options to reach markets further afield.</p> <p>This represents a significant opportunity for Malawi Fruits to reach new markets with a pre-existing supply of fruits if it can introduce new ways of distributing, packaging or processing the fruits. Irrigated land will considerably extend the season.</p>
Favourable growing conditions	<p>The Northern Region of Malawi, particularly in the target area around Rumphi and Chitipa, covers a wide topography and compares very well with other areas of Malawi. It should therefore be possible to significantly increase production of fruits, legumes and other crops providing the market opportunity is proven and a credible and effective operational model is developed. The land is good and irrigation multiplies the opportunities.</p>
Under-developed market	<p>The existing market for fruits and other crops in Northern Malawi is unorganized and lacks any form of value addition or processing. Such unorganized marketing systems have a bearing on overall production levels because of the uncertainty faced by farmers of an available market and predictable prices. Low prices offered on crops also affects production levels in the sense that farmers get discouraged because of the low prices which in most cases do not cover production costs.</p> <p>An opportunity thus exists for a buyer of crops to offer a fair price that then supports a sustainable processing venture. As a social enterprise with a track record as an intermediary and strong community links in the region, such a commitment is likely to be viewed more credibly by farmers and their representatives than may be the case with a purely commercial new entrant.</p>
Access to financial services	<p>Smallholder farmers are often resource poor and this is true of almost all farmers in the target region. This impedes their involvement in commercially oriented production systems. Crop production is thus constrained by lack of access to support institutions such as extension and financial services.</p>

	<p>As a foreign organisation with access to grant funding and other forms of investment, Malawi Fruits is well-placed to overcome these challenges. Further, Malawi Fruits has already established a track record of providing financial services at the local level in providing input finance to farmers on paprika (although repayment challenges remain).</p>
Government priority	<p>The Government of Malawi strongly favours value addition in manufactures as a 'cluster' under the National Export Strategy, in particular agro-processing as a sub-cluster. The government also seeks to improve an unfavourable trade balance through supporting the development of export products and those which can substitute for imports, i.e. are Malawi-produced. To this end, its relevant government agency, the Malawi Investment and Trade Centre (MITC), has established a one-stop shop approach to investing in Malawi, based in Lilongwe. It consolidates immigration, finance and land tenure components to facilitate investment.</p> <p>More specifically, the Rumphi and Mzuzu regions are viewed as favourable for growth, due to relatively low land pressures and higher average incomes than the south. While regional development plans are not always actively implemented in Malawi, there are signs that this region is being actively targeted (e.g. the new road leading from the M1 to the Rumphi escarpment).</p> <p>The Malawi Government also has a strong commitment to irrigation and has identified 50,000Ha of land in Rumphi District with irrigation potential: only 2,000Ha are currently irrigated.</p>

4.3 Challenges

Despite the above opportunities however, there remain challenges in increasing crop production and operating processing businesses in Malawi which must be considered. This Study argues for a high level of farmer training and support with quality seed stock and other inputs in order to address these issues. The challenges are assessed below:

Local varieties and poor quality of crops may limit market potential	Indigenous varieties of mango, banana and pineapple tend to yield a lower quality of fruit than is demanded by the international (and often local) market and may also mean they are not suitable for processing. Similar problems exist with sunflower and groundnut. Yield quantity can also be an issue, threatening farmers' livelihoods and meaning any future processing venture may have an unpredictable supply chain.
Disease	Without careful husbandry and good crop rotation (both training issues) diseases can spread quickly affecting quality and yield of crops and thus farmers' incomes. With groundnut there is the added hazard of Agri-toxins which are dangerous to humans and need to be carefully managed (again, a training and quality control issue).
Climate change	<p>Climate Change is one of the major challenges affecting the agricultural sector in the next 50 years. The International Panel on Climate Change (IPCC) predicts that it is 'extremely likely' that greenhouse gas emissions are changing the world's climate. The term 'global warming' is often used to describe this effect but the implications for local climates can be variable. The impact of continuously increasing concentrations of greenhouse gases in the atmosphere is likely to be significant in Malawi.</p> <p>The Malawi climate projections for the 2020-2040 period (using a high emissions scenario - RCP 8.5) are largely uniform across the country:</p> <ul style="list-style-type: none"> – Later start to the rainy season – Higher rainfall during mid-season – Earlier cessation of rainy season – Increases in mean and extreme temperatures in October and November <p>Climate change risk could be mitigated as follows:</p> <ul style="list-style-type: none"> – Diversification of crops ensures that risks are not all placed on one crop and one time of year – Shift to drought tolerant crops

	<ul style="list-style-type: none"> – Tree crops require less volume of water and less frequency of watering than most other crops – Train farmers in conservation farming techniques including mulching – Train farmers in rain water harvesting and storage – Work with development partner with common interest who can provide support in such areas
Infrastructure	<p>On-grid electricity supply is desirable but not essential for crop processing. This is simply not an option for more remote irrigation schemes so solar power will be the answer.</p> <p>The transport infrastructure is relatively good for transport to market, with a planned Service Centre facility being based near the M1 which is designed to transport large volumes of product by truck. However, local transport is more complex with limited roads that are subject to seasonal issues (i.e. they can be closed due to flooding in the rainy season). Again, this can be mitigated with effective planning.</p> <p>Lack of transportation and the high cost of vehicle hire often makes it impossible for smallholder farmers to access markets. This can be an opportunity for improvement for Malawi Fruits, since they will have access to vehicles and can take advantage of new road development in Rumphi.</p>
Financial incentives	<p>To the extent that input loans may be required, repayment and installation of a savings/reinvestment culture may be a problem as evidenced by the paprika venture. The venture may therefore run the risk of operating more as a charity than as a social enterprise. The learning from the paprika project would suggest that loans should be minimised as far as possible.</p>

5 Malawi Fruits and Nyika Food Trust – Partnerships and networks

Both NGOs have benefitted from working in partnership with a wide range of organisations including private companies, Government Departments, NGOs, Farmers' groups and international development networks.

5.1 Scotland-Malawi Partnership (SMP) and the Malawi-Scotland Partnership (MaSP)

MF and NFT are members of the relevant groups and play a full part in both organisations including participation in the Business and Trade Forum. There are links at Board level with both networks: Alan Laverock from MF serves on the Board of SMP and the Chief Officer of NFT is also Chair of MaSP.

5.2 Scottish Government

Both organisations have strong support from the Scottish Government. Malawi Fruits currently manages a government funded project supporting farmers to grow cash crops. In 2015 MF also delivered a Feasibility Project focusing on crop processing which was government funded.

5.3 Livingstonia Honey Producers

There is a long standing relationship and potential for installation of hives at the irrigation schemes to add to farmers' incomes and aid pollination of plants.

5.4 YESA Project.

YESA is Youth Entrepreneurship in Sustainable Agriculture and is a Malawi NGO supporting and training teenagers to participate in farming. They will be an important partner in supporting the organisation of farmers in the schemes and encouraging widespread community engagement.

5.5 Rumphi District Irrigation Department.

This is the Government Irrigation Department who have been closely involved in delivering this Feasibility Study. They have great detail on the potential for irrigation in the area; best practice from existing irrigation schemes; and links to other Malawi Government Departments. Their expert surveyors would be involved in delivering on the rehabilitation project.

5.6 Ex Agris and Tropha

These are the private companies who have supported the Paprika Project and are the buyers and exporters of the crop. They have large irrigated farms locally and are well-placed to provide help and support in that area. A key part of Malawi Fruits strategy is to build good relationships with buyers.

5.7 SeedCo

Another private company who partner with NFT Farmers to grow groundnut. This has been contract farming (2015/16) and points to the way forward for support for farmers on irrigated land.

5.8 Chigomezgo Farmers' Co-operative

Malawi Fruits is in partnership with the Co-operative to jointly operate a Sunflower Oil Processing factory. The factory inputs are grown by the farmers and some farmers also benefit through jobs at the factory. Malawi Fruits provided start-up finance and continues to provide support with business training, transport and marketing. The Co-operative was established by the Malawi Government organisation OVOP (One Village One Product) and the three-way partnership therefore continues.

5.9 Comic Relief

The funding of the current Feasibility Study is a vital partnership which is very much valued. This creates an opportunity to submit a further funding application (in July 2016) focused on the implementation of the findings.

5.10 The Management Committees of the irrigation schemes

These are the key partners for any future success. MF and NFT have built a good local reputation for organizing Farmers' Clubs for the Paprika Project and the learning from this will inform the growing relationship with the Management Committees. This engagement has begun and is growing through this Feasibility stage and needs to be subject to ongoing development and a formal MOU process as things move into the implementation stage.

5.11 The Traditional Authorities

In Malawi culture and tradition there are Village Headmen (GVH) who are the traditional authority in the area. In some villages women now take this role which was traditionally a male domain. These are similar to a tribal chief and such authorities are recognized by the Malawi Government and respected by the local people. NFT has always been careful to respect the GVH in the areas where Farmer's Clubs are operating and is building a good reputation through this. It will be important to build this respect and methodology into the plans for irrigation schemes.

6 The need for irrigation in Northern Malawi

The Malawi population is currently 17.2 million and is expected to reach 45 million by 2050. This growth in population will necessitate a substantial increase in food production which cannot be achieved through rain-fed agriculture alone. Unlike rain fed agriculture, irrigated agriculture produces high yields and provides opportunities for multiple cropping: at least two, and sometimes three crops per year can be achieved. Based on these advantages over rain fed agriculture, irrigated areas have been expanding over the years but with very mixed results. Additional irrigation schemes have not yielded the expected increase in food production across the nation because rain fed crops have been adversely affected by climate change. This is summarised in the following update from the Scotland-Malawi Partnership:

- **The country is facing the worst food insecurity in over a decade.** This is the result of late, erratic and highly localised 2015/16 rains; limited affordability of farm inputs; high prices of basic commodities; limited maize availability on markets and; flooding in early 2015 followed by drought in 2016.
- 6.5 million people (38% of total population) were declared at risk of severe food insecurity (up from 640,000 in 2014). The Government of Malawi requested international assistance in October 2015.
- Rains were late in parts of the country by up to 40 days for the current 2015/2016 growing season. Temperatures are higher than normal and soil conditions are dry. Rainfall is highly localised and erratic. Some areas have experienced crop failure, flooding and pest infestations destroying crops.
- Maize crop condition and yields are very variable. The country is at high risk of crop failure and ongoing below average rainfall in Southern and Central regions. It is predicted post March 2016 that Malawi will be in the Stressed (Integrated Phase Classification (IPC) Phase 2) and Crisis (IPC Phase 3) stages of food security (Source: FEWS NET).
- Maize prices are very high and increasing. Food availability on markets is unpredictable. Other commodities such as rice, sugar, salt and oil prices remain significantly higher than 2015 averages across the country, especially in the southern region.
- Erratic rain has eroded casual work opportunities at what is normally the peak labour season. Many people are surviving on pumpkin leaves (nkwani) and maize husk ground into flour (madeya). Strong kinship ties mean that those who have are sharing any form of assistance and this is helping people to get through a very difficult time. Anecdotal evidence suggests hunger is causing drop outs from school, early marriage and increased transactional sex (Source: Community consultations).
- Cholera outbreaks have occurred in some districts of Central, Northern and Southern Malawi. As of 06.02.16 there were 746 cumulative cases in 6 districts with 20 deaths (10 in health facilities/10 in communities).

- On 30th June 2016 the UK Government's Department for International Development (DFID) announced ongoing support of £24 million (23bn Malawi Kwacha) in response to the Government of Malawi's National Disaster Response Plan. This support from the UK will assist some of the 6.5 million people identified by the Malawi Vulnerability Assessment Committee (MVAC) food security assessment as requiring emergency food/cash assistance over the next nine months. This is likely to be the largest international humanitarian response in the country's history and is a result of widespread crop failure and poor harvests, exacerbated by the El Nino weather event. Late rains, long dry spells and floods in some areas, combined with poorly functioning markets, low food stocks, uncertain maize supplies and high inflation, has led to a potentially catastrophic situation.

This problem is compounded by poor irrigation scheme construction and management leading to many schemes being non-functioning or not reaching their full potential. This situation is exacerbated by increasing poverty among rural communities, increasing population pressure on a limited land resource base, land degradation arising from agricultural expansion and increasing deforestation to meet the increasing demands for energy, food and construction.

It is against this background that Malawi fruits is proposing a project in Rumphi district which will rehabilitate non-functioning irrigation schemes and put in place a support structure which will ensure that this time the irrigated land fulfils its potential and provides vital food security for the surrounding area. There will be a direct economic benefit to 1050 farmers (8400 people including their dependents) but the food security benefit goes much wider in the area.

The project has three main components:

1. Modernisation and rehabilitation of 11 irrigation schemes to provide 297 Hectares of irrigated land.
2. Support and training for the farmers in terms of crop selection, crop husbandry, secure markets for crops; business training and irrigation management and maintenance.
3. Provision of a Service Centre to provide additional services – mechanisation (tractors and plough; rotovators); bulk buying of inputs; transport for inputs and crops; etc. The Service Centre will allow for thorough and ongoing monitoring and evaluation (the Service Centre model is explored in Section 10 of this report).

6.1 Contributing to the Global Goals.

All good development must consider how it relates to the internationally recognized Global Goals which were launched in 2015. This Irrigation Project contributes directly and indirectly to nine of the goals as set out below:



The Goal is to end poverty in all its forms everywhere. Smallholder farmers in Northern Malawi are part of Malawi's urban poor and often survive on less than \$1.25 per day. This project has the potential to drive up incomes and lift them and their families out of extreme poverty.



The Goal is to end hunger, achieve food security and improved nutrition and promote sustainable agriculture. The linkage with providing well managed irrigated land is obvious with the potential to provide year-round food security and a wider range of crops to improve diet and nutrition.



The Goal is to Ensure healthy lives and promote well-being for all ages. Through improved incomes this project can enable people to access local health services when they need them. The proposed use of mechanisation reduces some of the extreme hard work, particularly for women and children and tackles child labour.



The Goal is to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. This project creates the potential to improve school attendance through mechanisation; to provide incomes to cover school fees and to provide solar energy to allow for evening study in people's homes.



The Goal is to achieve gender equality and empower all women and girls. In this project there is an opportunity to empower women to play a full part in Management Committees and thus gain influence over the work they do on the land. Providing irrigation has a significant impact on the amount of water carrying required by women and girls thus creating opportunities to use time and energy much more positively.



The Goal is to ensure access to affordable, reliable, sustainable and modern energy for all. On those schemes requiring solar pumps, there is an obvious opportunity to add to the provision to provide for the small scale power requirements of the people. None of the farmers have mains electricity so this simple provision can have a big impact.



The Goal is to promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all. The project does exactly this, making work in agriculture a good option without the extreme pain (through mechanisation) and with opportunities to grow income through good farm planning which is only really possible with irrigation.



The Goal is to take urgent action to combat climate change and its impacts. The principle driver for this Study is the need to mitigate the effects of climate change which are terrorising the lives of smallholder farmers. Irrigation protects them from the worst effects of climate change.



The Goal is to protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss. Well managed, irrigated farms allow for planning to promote crop rotation and soil regeneration and to get smarter about alternatives to excessive use of fertilisers and other inputs.

7 Transforming the lives of the farmers and their dependents

7.1 Malawi Fruits and NFT experience so far

The two NGOs have been working together since 2012 and have been supporting farmers to grow paprika (2014, 2015, 2016) and groundnut (2016). There are currently 488 farmers in the programme and evaluations show that there has been a significant improvement in the lives of these farmers and their 3500 dependents as shown in the table.

Summary of Smallholder Farmers backgrounds and how they benefit from growing paprika (Survey of 2014/15 farmers in the Paprika Programme.)

Background Factor	Percentage or number	Use of profits	Percentage applying profits on this
Access to clean water	67%	Home improvement	42%
Access to electricity	5% (all solar)	Education	20%
Average number of dependents	7.2	Business development	43%
Proportion of women farmers	47%	Buy food	6%

7.2 The long term vision

Malawi Fruits has a vision for a three stage approach to raising the income of smallholder farmers:

1. Support farmers to grow cash crops (already in place with the Scottish Government-funded Paprika Project).
2. Irrigate land to allow for multi-cropping (the subject of this study).
3. Add value to crops through agri-processing (Malawi Fruits has begun this work supporting a Farmers' Co-operative with a sunflower oil plant).

Each step in this process raises farmers' incomes and contributes directly to bringing change in their lives and the lives of their families.

This study identifies 11 irrigation schemes for rehabilitation and effective ongoing management. The unique *Service Centre* approach allows for good management, effective mechanisation, access to markets and many other benefits. In the longer term the well-managed irrigation schemes will provide crops for a range of small-scale agri-processing plants (dried fruits; jams & preserves; fish processing; animal feed manufacturing; etc).

7.3 The role of women farmers

Malawi Fruits and Nyika Food Trust have 47% women farmers in the Paprika Programme. All the evidence suggests that where women are empowered to earn money then it will be spent on the children and will benefit the whole family. This is backed up by Malawi Fruit's own observations. On the irrigation schemes, xxx% of the farmers are women and it will be important to ensure that women are proportionately represented on the management committees for the schemes.

7.4 The role of young people in the Schemes

Malawi has a young population (49% are youth), and its agro based economy (90% of GDP) and food security depends on a dwindling population of ageing farmers (average age 55). Malawi is also currently shifting towards crop diversification, mechanisation, irrigation and eco-friendly agriculture. However, young people are not encouraged to get involved in this economy despite young people forming 60% of the unemployed population. The youth (aged 15-24 years) also constitute the largest cohort ever to enter the transition to adulthood with the evidence showing that in Malawi teenagers are entering adulthood with little or no knowledge and skills that can enable them to become economically self-reliant. At the same time, evidence is showing a growing disillusionment with and disinterest in agricultural-based livelihoods among the youth in Malawi and the country is also heavily depending on imports due to a weak agro processing and value addition industry. The National curriculum covers agriculture and agri business from as early as standard 6 to 8, however the syllabus does not empower youth to be practically involved in any way. So students are gaining some knowledge but no skills in what is a hands-on industry.

Further disillusionment comes from the fact that the teachers unintentionally discourage youth from developing careers in agriculture through their comments and punishments. It is common to hear the following statement in class as they motivate or rebuke students; "work hard in studies, otherwise you will struggle, and be poor, farming in the villages". In addition, agriculture is the formal national punishment for prisoners and in most cases for schools. However, the agriculture sector with its diverse value chains offers particularly high opportunities for job creation compared to other sectors of the economy (National Youth policy 2013).

Lastly the disillusion stems from the general inability of the educational system in Malawi to prepare the youth for the challenges of after school life. This has contributed to the enormous youth unemployment and under-employment as Malawian curricula favours white collar jobs. For instance, the Malawi school syllabus does not cover critical life preparatory courses like entrepreneurship and financial literacy (saving, investment).

Engaging the youth in rural based agro processing and other parts of the value chain will reduce the high rates of rural-urban migration and high levels of youth unemployment. Engaging youth will also enable a gradual transition from ageing farmer populations to the next generation and cut back the increasing dependence on imported food.

With all this in view, proactive steps should be taken to support, train and encourage young people on the schemes to play a full part in farming. The use of mechanisation to take some of the pain from the work will be beneficial and the improved incomes possible from irrigated land make this a viable career option for local young people.

7.5 Child labour and education issues

In the most rural parts of Malawi there is a problem with child labour on farms. Any project looking to improve welfare must address this issue largely with interventions through education of farmers. However, there are at least two other interventions which have an impact: mechanisation can take the extreme hard work out of farming at key points in the year. Currently, at these times, every member of the family is drafted in to help on the farm because of the digging and hoeing which is required. Access to a tractor and plough can change this. Also, irrigated land will improve incomes making access to school easier. Primary education in Malawi is free but children are failing to attend because of lack of clothing or books. Fees are required for secondary education and this is beyond most subsistence farmers. Well managed irrigated land together with education about the necessity to avoid child labour, can bring about change in this area.

7.6 Smallholder farms as a business

The background is of households surviving on subsistence farming. Our intervention will put cash into thousands of these households giving them the means to pay for healthcare and education. There are other agencies working in this field but they concentrate on the more experienced and entrepreneurial farmers - many of whom end up growing tobacco even though the market is unpredictable and ethically questionable.

It is clear that a well-organised smallholder farm can provide for a family but there are many challenges. Access to irrigation and reliable markets are key steps to improving farmer incomes but experience of NFT and NASFAM (National Association of Smallholder Farmers) is that a cash income as a lump sum at harvest time does not always translate into a step change in the wellbeing of the farmer and her family. Subsistence farmers by definition live hand to mouth and so long term financial planning does not come naturally. A key requirement, therefore, is to provide good quality training to help farmers understand that their smallholding is a business and to help farmers develop a three-five-year vision. This encourages good investment and saving decisions and will produce long term change in their welfare and growth in their income.

8. Irrigation Schemes – Examining the reasons for failure

Detailed research has shown that there are failings which are common to all schemes and other challenges which are specific to individual schemes. This is detailed in the description of each scheme but the following summary highlights the challenges which must be addressed as the schemes are restored and extended.

8.1 Factors affecting all schemes

8.1.1 Misused funds

Malawi faces significant challenges with infrastructure projects because of the common practice of misusing donor funds. Government employees in agriculture and irrigation departments are not well paid and in the past infrastructure projects were viewed as a way for staff to augment their incomes through daily allowances. Inevitably this put pressure on budgets so research has found that all the schemes are incomplete in some way simply because funds ran out. In many cases canals ran only part of the planned distance reducing the area of land receiving water; in others, the canals were not lined with cement render to prevent water loss and ease the flow of the water.

8.1.2 Poor workmanship

Poor survey work has caused significant faults with the levels meaning that the water does not flow and so some land is not irrigated. Remedial work is possible in some cases but generally the sections of such canals have to be completely rebuilt. Poor quality bricks, mortar and cement render have been used – possibly related to dwindling funds through misuse of the funding. Skimping on cement in mortar and rendering has meant that surfaces have broken down in a relatively short space of time, restricting water flow. In every case, no sluice gates were provided meaning that farmers then used mud to divert the flow and this practice also restricts water flow.

8.1.3 Lack of maintenance

Where faults have developed in all schemes, there has been no remedial work. This is partly a management issue: there is no system for the farmers to pay for water when a small charge would have created a fund which could be used for remedial work and for planned maintenance.



8.1.4 Poor local management

It has been identified that a lack of support and training for the Management Committees of the schemes has led to poor decision making; factions; nepotism; and other similar problems affecting the fair use of the scheme. Over time this has meant that some land receives a great deal of water while other farmers' land receives very little or none. Such injustices lead to a breakdown in relationships and a lack of trust in the Management Committee.

8.2 Specific problems with schemes

8.2.1 Inadequate weirs

Five schemes have problems with the weir which provides the water intake. In some cases, this is a simple matter of renewing filters but with others substantial remedial work is required at the weirs.

8.2.2 Inappropriate pumps



There are three schemes with mechanical pumps which are diesel or petrol driven. These have been problematic from the outset because there was no provision for the farmers to have fuel and no plan for ongoing maintenance. All pumps are in poor condition or non-operational. With advances

in technology it is obvious that these pumps should now be solar powered.

8.2.3 Design flaws

Two schemes have major flaws in the design meaning that they have to be comprehensively re-designed and rebuilt in order to function correctly.

9. Irrigation Schemes – Resolving the issues

Section (8) above has summarised the challenges and plans are now in place to resolve these issues, learn from them and ensure that the schemes will be operational in the long term in the future. The various mitigations and solutions are identified below:

9.1 Addressing factors affecting all schemes

9.1.1 Misused funds

Sadly, significant problems remain within government departments in Malawi which mean that it would be unwise to entrust close supervision of the works to them. The proposed solution (funds permitting) is that the Chief Operating Officer of NFT (Andrew Namakoma) would personally oversee the work with Malawi Fruit's Development Executive (Atusaye Kayuni) being responsible for releasing funds for each section of the work in line with the agreed budgets.

9.1.2 Poor workmanship

Atusaye Kayuni has closely supervised the survey and laboratory work throughout this feasibility study and so there is confidence that the designs are now correct and the plans are robust. Close supervision of the works during construction will be required to ensure that what is proposed on paper is correctly implemented on the ground.

9.1.3 Lack of maintenance

This is a key issue and would be part of the function of the Service Centre (see Section 10) which means that there would be regular planned maintenance and any remedial works would be done in a timely manner. This plan also means that there will be consistency across all schemes and that expertise can be shared.

9.1.4 Poor local management

Another function of the Service Centre will be to provide support, training and capacity building to the various Management Committees. This is an area of particular expertise for Andrew Namakoma. Building the capacity of these committees is a key step towards supporting these groups to provide more of the services themselves in the longer term.

9.2 Addressing specific problems with schemes

9.2.1 Inadequate weirs

Re-designs and remedial works required have been identified in the scheme by scheme analysis in Section (11). Again, close supervision of this Feasibility Study by Malawi Fruits staff gives confidence that the designs and works specified will solve the problems.

9.2.2 Inappropriate pumps

The study proposes replacing all pumps with solar solutions and retaining mechanical pumps within the Service Centre as an emergency back-up only. Quotes from reputable companies have been obtained for solar pumps complete with all panels, controls, pipework and security provision.



9.2.3 Design flaws

Close supervision of this feasibility study gives confidence that the designs are now correct and all faults in the original designs have been identified and remedied.

10. Provision of a Service Centre: a management and maintenance service for the schemes.

10.1 The concept

In looking at all aspects of the value chain for agriculture, it has been identified that there are a large number of services which need to be provided. In some cases, the farmers are best placed to provide these services and, over time and with training, more and more of the services can be provided by the farmers themselves. Initially, there is a need for NFT to have a Service Centre which provides core services to all the farmers and to the irrigation schemes. The services which will be provided by the Service Centre are:

- a. **Farmer training** – covering crop husbandry; composting; fish farming training; irrigation management training; “My farm is a business” training & vision building; child labour awareness training; health & hygiene training.
- b. **Farm inputs** – access to good quality seed & other inputs and loans where appropriate. Bulk buying will ensure best prices for all farm inputs.
- c. **Irrigation maintenance** – the Service Centre will maintain all irrigation schemes
- d. **Mechanisation** – tractor & plough and rotovators will be available to all irrigation schemes from the Service Centre
- e. **Transport** – provision of transport for inputs to farms and for crops to market
- f. **Sourcing of markets for crops and therefore advising farmers on crop selection.** This will be farming under contract wherever possible. There is huge potential here for tying in with crop processing which is the next part of Malawi Fruits’ long term vision and will further increase farmers’ incomes.

10.2 Costs for Service Centre

There are capital costs to establish the centre including a small building. Thereafter, there are running costs which will need to be grant-funded initially and, in terms of education and training, there will be some costs for two years which are not required long-term.

Capital Costs	£
Tractor and plough	10,000
Rotovators x 3	3,000
Motorbikes x3	7,000
Two ton pick up	8,000
Land & buildings	25,000
Office equipment	1,000
Total	54,000

Running Costs	£ Year 1	£ Year 2	£ ongoing
Salaries (a)	25,000	25000	19250
Fuel	2,000	2000	2000
Irrigation maintenance materials	2,000	2,000	4,000
Equipment running costs	3,000	3,000	3,000
Provision for equipment replacement (20%pa)	5,600	5600	5600
Totals	37,600	37,600	33,850

- a) Staff is a Principal Officer (£8800); 3 training officers (£8600); a driver/mechanic (£1700); a maintenance officer (£2900); security guards (£3000). By year 3 only one training officer will be required.

10.3 Income streams for Service Centre

The Service Centre needs to be self-sustaining in the long term even though it will be established through grant funding and fundraising. The Service Centre model is efficient in terms of shared management, shared capital costs (e.g. motorbikes for Farm Extension Workers) and economies of scale such as buying power for inputs and best prices for sale of crops. There are several income streams:

- Irrigation maintenance charges to farmers on irrigated land.
- Charges to farmers for use of tractors, rotovators etc. These charges can be on credit until harvest time.
- Commission on crop sales and contract farming. On average this will be 6% of all crop sales.
- Sales of services to other NGOs and to commercial farmers – NB. The smallholder farmers in the NFT programme will always have priority but services can be sold during down time.

11. Irrigation schemes: condition, solutions and costs

Each of the 11 schemes have some infrastructure on the ground and a Management Committee (or at least the remnants of one). Each scheme has been inspected carefully and drawings have been prepared (Appendix 1); soil and water analysis has been completed (Appendix 2) and Bills of Quantities have been prepared (Appendix 3).

For effective management and operation of the schemes, Operation and Maintenance Manuals will be produced after successful completion of rehabilitation works and it is envisaged that the following training will be conducted:

- Group dynamics and leadership
- Community based monitoring and evaluation
- Record keeping, accounting and book keeping
- Production planning and process
- Irrigation water management (crop water requirement, water scheduling, irrigation method)
- Environmental conservation and protection
- Crop cultural practices, husbandry and field layout
- Scheme operation and maintenance

Ongoing support in all these areas will be provided by the Service Centre.

Each scheme will have a Management Committee (all of these need to be re-constituted) and the duties of the Committee would be:

- (i) To keep records of daily activities
- (ii) To manage local financial aspects including collecting fees
- (iii) To control water usage
- (iv) To work with the Service Centre for crop selection and markets
- (v) To operate the facility and work with the Service Centre for maintenance works
- (vi) To settle disputes among the members

11.1 Bethani Irrigation scheme

11.1.1 Outline of Irrigation System and Facilities

Bethani Irrigation Scheme, which is categorised as the gravity type, was started in 2004 with support of the Government of Malawi (GOM) and African Development Bank under the Rural Income Enhancement Project. However due to some financial limitations the canals were not lined thereby creating some gullies in most parts. In addition, the excessive flooding of Ruviri River has damaged some parts of the weir. Major irrigation problems and proposed solutions are summarised in Table1 while the drawings are contained in Appendix 1:

Table 1: Major problems and proposed solutions for Bethani

Structure	Reasons for failure to operate effectively	Recommendations
Weir	Damaged parts, lack of screen into the main line, missing weir apron, leakages	Repairing of damaged parts, insertion of screen, construction of apron, to repair the weir
Main Pipe line	Exposed pipe, suspended pipe	Reinforcement of supporting pillars
Secondary Canal (Right side)	Unlined (849m), damaged distribution boxes (9)	Lining of canals and construction of distribution boxes
Secondary Canal (Left side)	Unlined (506m), damaged distribution boxes (5)	Lining of canals and construction of distribution boxes
Tertiary canals (Right side)	Unlined (1700m), gullies, lack of distribution boxes and drop structures	Lining of canals, construction of distribution boxes and drop structures
Tertiary canals (Left side)	Unlined (1665m), gullies, lack of distribution boxes and drop structures	Lining of canals, construction of distribution boxes and drop structures
Crossings	No.1,2,3,4 (pipes on site), 5,6 (pipes on site), 7	Install 500mm culvert rings, repair wing walls, install GI pipes (18m) pumps are on site, install GI Pipes 30m, install GI pipes are on site, install 8m GI

11.1.2 Management of Irrigation Water Distribution

Irrigation water source is the Ruviri River and is enough to irrigate the area of 28 ha. Current cultivated area is 22ha.

11.1.3 Farmers Organization

Presently there are 108 members with an average land holding of 0.20 ha, cultivating about 22 ha of farmland. These scheme members originate from Munyongani village under T/A Chisovya.

11.1.4 Cost of refurbishment of Bethani Irrigation Scheme

The total cost of refurbishment of Bethani irrigation scheme is **MK 39,182,345**. The full details are contained in appendix 1.

11.2 Chagumukire Irrigation scheme

11.2.1 Outline of Irrigation System and Facilities

Chagumukire Irrigation Scheme, which is a pumped irrigation type, started in 2012 with support of the Government of Malawi (GOM) and African Development Bank under the Smallholder Crop Production and Marketing Project. However, the designed off-take structures from the canals were siphons that posed a big challenge. In addition, the excessive flooding of South Rukuru River has damaged some parts of the flood protection bund. Further to that tertiary canals were not constructed due to financial limitations. Major irrigation problems and proposed solutions are summarised in Table 2.

Table 2: Major problems and recommendations for Chagumukire

Structure	Reasons for failure to operate effectively	Recommendations
Pumps	High operation cost and poor reliability due to historic poor maintenance	Need to change the pumps to solar driven for sustainability (3 pumps – one for each block)
Hydrant	Cracks in hydrant 1	Maintenance of the cracks
Secondary canals	Cracks in secondary canal Improper levels in SC1(350m) No distribution boxes (6) No drains	Maintenance of the cracks Rework levels Insert distribution boxes Provide drains
Main canal	Developed cracks Bed level is low(1804m) No distribution boxes (6) Eroded canal	Maintenance of the cracks (60) Rework levels and in some parts reconstruction is required (250m) DBs needs to be constructed (48) Reconstruction

Tertiary canals	No tertiary canals available	Construction of tertiary canals (3400m), turn out structures, drop structures and tail end structures
Drains	No tertiary drains	Excavation of tertiary drains (3400m)
Flood protection bund (FPB)	Breached	Maintenance of the FPB Southern - (90m); Northern – (80m)

11.2.2 Management of Irrigation Water Distribution

Irrigation water source is the South Rukuru River and is enough to irrigate the area of 45 ha. Currently no land is being irrigated.

11.2.3 Farmers Organization

Presently there are 143 members with an average land holding of 0.31 ha. These scheme members originate from Kakloha village under T/A Mwachenga.

11.2.4 Cost of refurbishment of Chagumukire Irrigation Scheme

The total cost of refurbishment of Chagumukire irrigation scheme is **MK 101,194,646** . It should be noted however that the total bill is high due to the high cost of procurement and installation of solar pumps.

11.3 Tambako Irrigation scheme

11.3.1 Outline of Irrigation System and Facilities

Tambako Irrigation Scheme, which is a pumped irrigation type, started in 2008 with support of the Government of Malawi (GOM) and African Development Bank under the Horticulture and Food Production Project. However, the designed offtake structures from the canals were siphons that posed a big challenge. In addition, there has been excessive damage in some areas. Further to that most farmers are poor and do not have money to buy fuel for irrigation. Major irrigation problems and proposed recommendations are summarised in Table 3.

Table 3: Major problems and recommendations for Tambako

Structure	Reasons for failure to operate effectively	Recommendations
Pumps	Pumps too old	Keep them serviced all the time Need to change the system to solar powered
Main canal	Cracks observed Collapsing of the canal (1400m)	Maintenance of the cracks (50m) Reconstruction
Secondary canals	No turn out structures Collapsed part No tail end structures	Construction of turn out structures (56) Reconstruction (1400m) of the canal Reconstruction (500m)
Drains	No tertiary drains	Excavation of tertiary drains (2000m)

11.3.2 Management of Irrigation Water Distribution

Irrigation water source is the South Rukuru River and is enough to irrigate the area of 40 ha.

11.3.3 Farmers Organization

Presently there are 120 members with an average land holding of 0.33 ha. These scheme members originate from Baghaya village under T/A Chisovya.

11.3.4 Cost of refurbishment of Tambako Irrigation Scheme

The total cost of refurbishment of Tambako irrigation scheme is **MK 84,174,362**. It should be noted however that the total bill is so high due to the high cost of procurement and installation of solar pumps.

11.4 Tapukwa Irrigation scheme

11.4.1 Outline of Irrigation System and Facilities

Tapukwa Irrigation Scheme, which is categorised as the gravity type, was started in 2004 with support of the Government of Malawi (GOM) and Irrigation of Rural Livelihood and Agriculture Development Project (IRLADP). However, in some parts of the scheme the canals were not completed. In addition, the weir has little water during peak periods due to seepage. Major irrigation problems and proposed solutions are summarised in Table 4.

Table 4: Major problems and proposed solutions for Tapukwa

Structure	Reasons for failure to operate effectively	Recommendations
Weir	During peak periods little water is available due to seepage	To re-allocate it upstream 100m away
Main Pipe line	Damaged pipes	30 pipes required (160mm class 6)
Secondary Canal (Right side)	Unlined (1600m), damaged distribution boxes (15) Problems in crossing Low bed levels (15m) No over pass Uncompleted canal (450m)	Lining of canals and construction of distribution boxes Provision of slabs Reworking on the levels Provision of pipes (30m) Construct the canal
Drains	No availability of drains	Provision of drains

11.4.2 Management of Irrigation Water Distribution

Irrigation water source is the Msongolo River and is enough to irrigate the area of 27 ha.

11.4.3 Farmers Organization

Presently there are 103 members with an average land holding of 0.26 ha. These scheme members originate from Makandula village under T/A Mwahenga.

11.4.4 Cost of refurbishment of Tapukwa Irrigation Scheme

The total cost of refurbishment of Tapukwa irrigation scheme is **MK10,353,330**

11.5 Kasengendule Irrigation scheme

11.5.1 Outline of Irrigation System and Facilities

Kasengendule Irrigation Scheme, which is categorized as the gravity type, was started in 2001 with support of the Government of Malawi (GOM) and Farmers. However due to some financial limitations the canals were not lined thereby creating some gullies in most parts. In addition, the excessive flooding of Nchenachana River has damaged some parts of the weir. Major irrigation problems and proposed solutions are summarised in Table 5.

Table 5: Major problems and proposed solutions for Kasengendule

Structure	Reasons for failure to operate effectively	Recommendations
Weir	No weir	To construct a new weir
Main Pipe line	No pipes (60m)	To procure pipes
Main Canal side)	Unlined (650m), No distribution boxes (13)	Lining of canals and construction of distribution boxes
Secondary Canal	No Secondary canal (1170m)	construction of SC

11.5.2 Management of Irrigation Water Distribution

Irrigation water source is the Kasengendule River and is enough to irrigate the area of 8 ha.

11.5.3 Farmers Organization

Presently there are 39 members with an average land holding of 0.21 ha, cultivating about 30 ha of farmland.

11.5.4 Cost of refurbishment of Kasengendule Irrigation Scheme

The total cost of refurbishment of Kasengendule irrigation scheme is **MK10,094,603**

11.6 Mbulakusamba Irrigation scheme

11.6.1 Outline of Irrigation System and Facilities

Mbulakusamba Irrigation Scheme, which is categorised as the gravity type, was started in 2004 with support of the Government of Malawi (GOM) and African Development Bank under the Rural Income Enhancement Project. However due to some financial limitations the canals were not lined thereby creating some gullies in most parts. In addition, the excessive flooding of Lura River has damaged some parts of the weir. Major irrigation problems and proposed solutions are summarised in Table 6.

Table 6: Major problems and proposed solutions for Mbulakusamba

Structure	Reasons for failure to operate effectively	Recommendations	Remarks
Weir	Weir not usable (15m)	Need to construct a weir	Height (1.22m)
Main Pipe line	No pipe (6m) (160mm)	GI required with 2 supporting pillars	
Main canal	Unlined(800m) No DBs (13) No drop structures (65) No tail end structures	Line the canal Construct DBs Construct Drop Structures and tail end.	There is fish pond which requires pipes from canal to fish pond about 60m of 110mm
Secondary Canal	No secondary canals	Construct 13 SC of 80m at the interval of 60m	

11.6.2 Management of Irrigation Water Distribution

Irrigation water source is the Lura River and is enough to irrigate the area of 7 ha.

11.6.3 Farmers Organization

Presently there are 25 members with an average land holding of 0.28 ha, cultivating about 7 ha of farmland.

11.6.4 Cost of refurbishment of Mbulakusamba Irrigation Scheme

The total cost of refurbishment of Mbulakusamba irrigation scheme is **MK 13,957,314**

11.7 Lumbwezi Irrigation scheme

11.7.1 Outline of Irrigation System and Facilities

Lumbwezi irrigation Scheme, which is categorised as the gravity type, was started in 2004 with support of the Government of Malawi (GOM) and African Development Bank under the Rural Income Enhancement Project. However due to some financial limitations the canals were not lined thereby creating some gullies in most parts. In addition, the excessive flooding of Lura River has damaged some parts of the weir. Major irrigation problems and proposed solutions are summarised in Table 7.

Table 7: Major problems and proposed solutions for Lumbwezi

Structure	Reasons for failure to operate effectively	Recommendations	Remarks
Weir	No weir	Construct weir	Height (1.22m) Side slope of the stream (1.7m)
Main Pipe line	Damaged	Replace 430m (160mm)	
Secondary Canal	No secondary canals	Construct 3 canals of 213m at interval of 55m and	
Tertiary canals	No tertiary canals	5 tertiary canals of 300m to be constructed	
Distribution boxes	No distribution boxes	60 distribution boxes to be constructed	

11.7.2 Management of Irrigation Water Distribution

Irrigation water source is the Lura River and is enough to irrigate the area of 30 ha.

11.7.3 Farmers Organization

Presently there are 128 members with an average land holding of 0.24 ha, cultivating about 30 ha of farmland.

11.7.4 Cost of refurbishment of Lumbwezi Irrigation Scheme

The total cost of refurbishment of Lumbwezi irrigation scheme is **MK 16,837,819**

11.8 Chivungulu Irrigation scheme

11.8.1 Outline of Irrigation System and Facilities

Chivungulu Irrigation Scheme, which is categorised as a pump based type, was started in 2004 with support of the Government of Malawi (GOM) and MIDSUP. However due to some financial limitations the canals were not completed. In addition, the pumps need to be replaced. Major irrigation problems and proposed solutions are summarised in Table 8.

Table 8: Major problems and proposed solutions for Chivungulu

Structure	Reasons for failure to operate effectively	Recommendations
Borehole/ river	Non-working pumps	Install solar powered pumps
Main canal	Incomplete	420m canal to be constructed
Secondary Canal	No secondary canal	Construct 2604m long canal
Distribution boxes	Incomplete	23 distribution boxes to be constructed

11.8.2 Management of Irrigation Water Distribution

Irrigation water source is the South Rukuru River and is enough to irrigate the area of 36 ha.

11.8.3 Farmers Organization

Presently there are 175 members (115m, 60f) with an average land holding of 0.21 ha, cultivating about 37 ha of farmland.

11.8.4 Cost of refurbishment of Chivungulu Irrigation Scheme

The total cost of refurbishment of Chivungulu irrigation scheme is **MK 93,103,048**. It should be noted however that the total bill is so high due to the high cost of procurement and installation of solar pumps.

11.9 Chayina Irrigation scheme

11.9.1 Outline of Irrigation System and Facilities

Chayina Irrigation Scheme, which is categorised as the gravity type, was started in 2004 with support of the Government of Malawi (GOM) and African Development Bank under the Rural Income Enhancement Project. However due to some financial limitations the canals were not lined thereby creating some gullies in most parts. In addition, the excessive flooding of Lura River has damaged some parts of the weir. Major irrigation problems and proposed solutions are summarised in Table 9.

Table 9: Major problems and proposed solutions for Chayina scheme

Structure	Reasons for failure to operate effectively	Recommendations
Weir	No intake chamber cover Flood damage to weir	Intake chamber cover to be constructed Repair flood damage
Main Pipe line	Pipes not covered	Refilling of pipeline
Main canal	Bottom width damaged (530m) Holders damaged (65m) Bearer block for drop structures damaged (16)	Repair bottom width and extend the MC (60m) 65m to be repaired 16 bearer blocks for drop structures damaged
Tertiary Canal	Uncompleted	Needs to be extended (800m)

11.9.2 Management of Irrigation Water Distribution

Irrigation water source is the Lura River and is enough to irrigate the area of 30 ha.

11.9.3 Farmers Organization

Presently there are 40 members with an average land holding of 0.75 ha, cultivating about 30 ha of farmland.

11.9.4 Cost of refurbishment of Chayina Irrigation Scheme

The total cost of maintenance of Chayina irrigation scheme is MK10,529,800

11.10 Chankhama Irrigation scheme

11.10.1 Outline of Irrigation System and Facilities

Chankhama Irrigation Scheme, which is categorised as the gravity type, was started in 2004 with support of the Government of Malawi (GOM) and African Development Bank under the Rural Income Enhancement Project. However due to some financial limitations the canals were not lined thereby creating some gullies in most parts. Major irrigation problems and proposed solutions are summarised in Table 10.

Table 10: Major problems and proposed solutions for Chankhama scheme

Structure	Reasons for failure to operate effectively	Recommendations
Weir	No intake chamber cover	Intake chamber cover to be constructed
Main Pipe line	Pipes not covered	Refilling of pipeline
Main canal	Bottom width damaged (670m) Holders damaged(84m) Drop structures damaged (50) left bank Bather block for drop structures damaged (16)	Repair bottom width and extend the MC (60m) 84m to be repaired Reconstruction of drop structures (50) 16 bather blocks for drop structures damaged
Tertiary Canal	Uncompleted No tail end structures (16) Left bank canal No 8 developed cracks(30m) Tertiary drain not constructed(670m)	Needs to be extended (800m) Construct tail end structures Partial lining of canal(30m) Construction of tertiary drain(670m)

11.10.2 Management of Irrigation Water Distribution

Irrigation water source is the Hewe River and is enough to irrigate the areas of 36 ha.

11.10.3 Farmers Organization

Presently there are 174 members with an average land holding of 0.21 ha, cultivating about 30 ha of farmland. These scheme members originate from Nthawathawa village under T/A Katumbi .

11.10.4 Cost of refurbishment of Chankhama Irrigation Scheme

The total cost of refurbishment of Chankhama irrigation scheme is MK**18,253,314**

11.11 Mphande Irrigation scheme

11.11.1 Outline of Irrigation System and Facilities

Mphande Irrigation Scheme, which is categorized as the gravity type, was started in 2004 with a support of the Government of Malawi (GOM) and African Development Bank under the Rural Income Enhancement Project. However due to some financial limitations the canals were not lined thereby creating some gullies in most parts. In addition, the weir on the Manchewe River requires to be rebuilt. Major irrigation problems and proposed solutions are summarised in Table 11.

Table 11: Major problems and proposed solutions for Mphande scheme

Structure	Reasons for failure to operate effectively	Recommendations
Weir	Wrong location of weir	Rebuild the weir in the correct position.
Main Pipe line	Pipes not covered	Refilling of pipeline
Main canal	Bottom width damaged (670m) Holders damaged(84m) Drop structures damaged (50) left bank Bather block for drop structures damaged (16)	Repair bottom width and extend the MC (60m) 84m to be repaired Reconstruction of drop structures (50) 16 bather blocks for drop structures damaged
Tertiary Canal	Uncompleted No tail end structures (16) Left bank canal No 8 developed cracks(30m) Tertiary drain not constructed(670m)	Needs to be extended (800m) Construct tail end structures Partial lining of canal(30m) Construction of tertiary drain(670m)

11.11.2 Management of Irrigation Water Distribution

Irrigation water source is the Manchewe River and is enough to irrigate the area of 10 ha.

11.11.3 Farmers Organization

Presently there are 108 members with an average land holding of 0.09 ha, cultivating about 10 ha of farmland.

11.11.4 Cost of refurbishment of Mphande Irrigation Scheme

The total cost of refurbishment of Mphande irrigation scheme is **MK 20,626,777**

12. Potential for fish farming and costs

This study has considered the potential for fish farming on the irrigation schemes. This is very much encouraged by the Malawi Government Agriculture Department and there are various advantages:

- Fish eat mosquito larvae reducing the insect population and therefore the malaria risk
- Fish is a good source of protein and other nutrients for the local people
- Fish sales could diversify farm incomes

There are a number of challenges however, including security (fish are regularly stolen) and poor markets. As part of the research, Stirling University were consulted because they are supporting a commercial fish farm project in the South of Malawi. They have concluded that fish farming on a small scale is not commercially viable at this stage due to the low prices and small market.

It would be beneficial therefore, to plan for small ponds on the schemes with a flow through of water from irrigation. A non-commercial operation would provide health benefits for local people at low cost and provide a more varied diet. Such ponds could be constructed by the farmers themselves and stocked cheaply. A budget of £1200 per irrigation scheme to set this up would be appropriate.

13. Crop assessment

In light of the soil analysis, a lot of work was done on crop identification. Of course, in practice, the biggest determining factor at any point in time will be the strength of the market for a particular crop. This has been the deciding issue in the work of Malawi Fruits/NFT up to this point. In 2013 it was becoming clear that tobacco, long the mainstay cash crop in Malawi, was no longer a viable option. Without support, however, smallholder farmers find it difficult to divert from what they know or from what appears to have worked in the past. Paprika and groundnut were chosen by Malawi Fruits because secure markets were found and then sensitization of the farmers led to the growth in that programme.

The point of this crop selection exercise was largely to determine what range of crops could be economically grown given the soil conditions. The final choice of crops in any given year will be a mix of the need to have a robust market; the need for crop rotation; and the need to use certain crops as “nitrogen fixers”.

The tables below analyse the inputs required for various crops and the returns from growing these crops. Irrigated land will, of course, give two crops per year so the returns can be very good for the farmer and the small contribution from each kg of crop to the Service Centre costs makes that provision viable.

No.	Name of Scheme	Total Irrigable Ha	Maize						Cost (MK)
			Area (ha)	Maize Seed (Kgs)	Cost (Mk)	23:21:0 (50 kgs Bags)	Cost (Mk)	Urea (50 Kgs Bags)	
1	Chagumukire	45	12	300	360,000.00	24	672,000.00	36	1,072,800.00
2	Chivungulu	37	7	175	210,000.00	14	392,000.00	21	625,800.00
3	Tambako	40	8	200	240,000.00	16	448,000.00	24	715,200.00
4	Bethani	28	13	325	390,000.00	26	728,000.00	39	1,162,200.00
5	Tapukwa	27	9	225	270,000.00	18	504,000.00	27	804,600.00
6	Chankhama	36	10	250	300,000.00	20	560,000.00	30	894,000.00
7	Kasengendule	8	2	50	60,000.00	4	112,000.00	6	178,800.00
8	Mbulakusamba	7	9	225	270,000.00	18	504,000.00	27	804,600.00
10	Mphande	10	7	175	210,000.00	14	392,000.00	21	625,800.00
11	Lumbwezi	30	5	125	150,000.00	10	280,000.00	15	447,000.00
12	Chayina	30	8	200	240,000.00	16	448,000.00	24	715,200.00
Grand Total		298	90	2250	2,400,000.00	180	5,040,000.00	270	8,046,000.00

Name of Scheme	Total Irrigable Ha	Paprika						Cost Mk
		Area (ha)	Paprika Seed (250gms)	cost (Mk)	D. Compound (50 Kgs)	Cost Mk	CAN	
Chagumukire	45	7	35	28,000.00	70	2,261,000.00	7	224,000.00
Chivungulu	37	8	40	32,000.00	80	2,584,000.00	8	256,000.00
Tambako	40	6	30	24,000.00	60	1,938,000.00	6	192,000.00
Bethani	28	12	60	48,000.00	120	3,876,000.00	12	384,000.00
Tapukwa	27	4	20	16,000.00	40	1,292,000.00	4	128,000.00
Chankhama	36	9	45	36,000.00	90	2,907,000.00	9	288,000.00
Kasengendule	8	0	0	0.00	0	0.00	0	0.00
Mbulakusamba	7	5	25	20,000.00	50	1,615,000.00	5	160,000.00
Mphande	10	6	30	24,000.00	60	1,938,000.00	6	192,000.00
Lumbwezi	30	7	35	28,000.00	70	2,261,000.00	7	224,000.00
Chayina	30	8	40	32,000.00	80	2,584,000.00	8	256,000.00
	298	72	360	288,000.00	720	23,256,000.00	72	2,304,000.00

	Beans		
Name of Scheme	Area (Ha)	Bean Seed (Kg)	Cost Mk
Chagumukire	2	200	480,000.00
Chivungulu	3	300	720,000.00
Tambako	2	200	480,000.00
Bethani	4	400	960,000.00
Tapukwa	2	200	480,000.00
Chankhama	2	200	480,000.00
Kasengendule	0.5	50	120,000.00
Mbulakusamba	3	300	720,000.00
Mphande	1	100	240,000.00
Lumbwezi	3	300	720,000.00
Chayina	2	200	480,000.00
		2450	5880000

	Sunflower		
Name of Scheme	Area (ha)	Seed (kg)	Cost (Mk)
Chagumukire	10	100	36,000.00
Chivungulu	3	30	10,800.00
Tambako	5	50	18,000.00
Bethani	0	0	0.00
Tapukwa	2	20	7,200.00
Chankhama	2	20	7,200.00
Kasengendule	0	0	0.00
Mbulakusamba	5	50	18,000.00
Mphande	0	0	0.00
Lumbwezi	3	30	10,800.00
Chayina	2	20	7,200.00
	32	320	115,200.00

	Cow Peas		
Name of Scheme	Area (ha)	Seed (Kg)	Cost Mk
Chagumukire	0	0	0
Chivungulu	2	80	136000
Tambako	5	200	340000
Bethani	5	200	340000
Tapukwa	3	120	204000
Chankhama	0	0	0
Kasengendule	0.5	20	34000
Mbulakusamba	3	120	204000
Mphande	0	0	0
Lumbwezi	3	120	204000
Chayina	1	40	68000
	22.5	900	1530000

Gross Margin Analysis - Beans

Beans

DETAILS	UNIT	QUANTITY	UNIT PRICE	TOTAL PRICE
REVENUE:				
Yield (Kg/ha)	Yield (Kg/ha)	800	600	480,000
Gross Revenue/ha				480,000
Costs MK/ha				
INPUTS				
Seed	kg	90	950	85,500
pesticides(Dimethoate)	bottles	1	5600	5,600
Innoculant	packet	0	0	0
Rented				18,750
Sub-total				109,850
LABOUR				
Clearing		8	600	12,000
Ridging		10	600	15,000
Innoculation		0	0	0
Pesticides application		4	600	6,000
Planting		10	0	0
Gap filling		4	0	0
First weeding		4	0	0
Second weeding		4	0	0
Banking		10	0	0
Harvesting		10	0	0
Stripping/threshing		4	0	0
Winnowing/Grading		4	0	0
Packaging		2	0	0
Total man-days		74		33,000
POST-HARVEST COSTS				
Transport to buyer		16	500	8,000
Loading		16	50	800
Packaging materials		16	150	2,400
Sub-total				11,200
Grand total costs MK/ha				154,050
Gross Margin (MK/ha)				325,950
Break-even price	MK/kg			193
Break-even yield	kg			257
Determined price at 15%				221
Determined price at 20%				231

Determined price at 30%

250

Gross Margin Analysis - Sunflower

Sunflower

Details	UNIT NO.	QUANTITY	UNIT PRICE	TOTAL PRICE
REVENUE:				
Sales		2,000	210	420,000
Gross Revenue/ha				420,000
Costs MK/ha				
INPUTS				
Seed		100	1200	120,000
Fertilizer Basal dressing	23:21:0+4s		25,000	0
Top dressing	Urea		24000	0
Rent				0
Sub-total				120,000
LABOUR (mandays/ha)				
Clearing		10	600	15,000
Ridging		25	600	37,500
Planting		10	600	15,000
weeding		10	600	15,000
Banking		25	600	37,500
Pest and disease control			600	0
Harvesting		15	600	22,500
Threshing		3	600	4,500
Drying		3	600	4,500
Grading		3	600	4,500
Packaging		3	600	4,500
Loading		3	600	4,500
Total man-days		110		165,000
POST-HARVEST COSTS				
Transport to buyer		40	250	10,000
Packaging materials		40	150	6,000
Sub-total				16,000
Grand total costs MK/ha				301,000
Gross Margin (MK/ha)				119,000
Break-even price	MK/kg			151
Break-even yield	kg			1433
Determined price at 15%				36

Determined price at 20%				181
Determined price at 30%				196

Gross Margin Analysis - Cowpeas

Cowpeas

DETAILS	UNIT	QUANTITY	UNIT PRICE	TOTAL PRICE
REVENUE:				
Yield (Kg/ha)	Yield (Kg/ha)	500	600	300,000
Gross Revenue/ha				300,000
Costs MK/ha				
INPUTS				
Seed	kg	20	950	19,000
pesticides(Dimethoate)	bottles	1	5600	5,600
Rented				18,750
Sub-total				43,350
LABOUR				
Clearing		8	600	12,000
Ridging		10	600	15,000
Innoculation		0	0	0
Pesticides application		4	600	6,000
Planting		10	0	0
Gap filling		4	0	0
First weeding		4	600	6,000
Second weeding		4	600	6,000
Banking		10	600	15,000
Harvesting		10	600	15,000
Stripping/threshing		4	600	6,000
Winnowing/Grading		4	600	6,000
Packaging		2	600	3,000
Total man-days		74		90,000
Grand total costs MK/ha				133,350
Gross Margin (MK/ha)				166,650
Break-even price	MK/kg			267
Break-even yield	kg			222
Determined price at 15%				307
Determined price at 20%				320
Determined price at 30%				347

14. Potential for mechanisation with costs

Even though 90% of Malawi's GDP comes from agriculture, the sector is very undeveloped. There is minimal mechanisation – even oxen and ploughs are rare and tractors are very scarce indeed. The work is back breaking in a hot sun and the demand for labour for the hard manual work means that mothers and children are in the fields when mothers could be caring for their families at home and the children should be in school.

This study has looked at the potential to manage the land on 11 large irrigation schemes and this creates an opportunity to provide mechanisation at a sensible cost. This is explored more in Section (10) under the Service Centre Model. Mechanisation offers some key benefits:

- Reduction in child labour so children can be in school
- Improved efficiency bringing higher incomes
- Unused land is able to be cultivated
- Farmers with poor health or who are older find some relief
- People have more time and energy to develop their farms in other ways.

Costs are detailed in Section (10) but initial grant funding of £13000 would provide a tractor and rotovators, with small charges levied to the farmers then covering all running costs plus a fund for replacement of equipment.



15. Risk Assessment Summary

15.1 Methodology

Risks have been identified throughout this Study and are summarised in the table 15.2 below. Table 15.1 shows the scoring method which has been applied to measure the likelihood and severity of each risk.

Table 15.1 Risk scoring matrix

Likelihood	Potential Consequence				
	Negligible	Minor	Moderate	Major	Extreme
Almost Certain	Medium	High	High	Very high	Very high
Likely	Medium	Medium	High	High	Very high
Possible	Low	Medium	Medium	High	High
Unlikely	Low	Medium	Medium	Medium	High
Rare	Low	Low	Low	Medium	Medium

Table 15.2 Risk assessment summary table

Identified Risk	Risk factor	Steps to reduce risk
Poor design of project		1. Design work has been completed by irrigation experts. 2. Designs to be checked before implementation
Poor construction or materials		1. Closely supervise works using trusted NGO staff.
Project exceeds budget		1. Malawi Fruits to have overall budgetary control. 2. Closely monitor the project throughout and release funds monthly based on approved budgets.
Inability of farmers to work together		1. NFT to use their experience in this area including peer education models. 2. Clear dispute resolution policies to be in place.
Unwillingness of farmers to co-operate with NFT/Malawi Fruits		1. All agreements to be reduced to signed written agreements. 2. Clarity about the rewards of participation and the consequences of dropping out to be given through training.
Severe weather disruption		1. Design features to mitigate post construction weather events have been built in. 2. Construction timescales are not critical so risk is low. 3. Service Centre maintenance team must be able to respond quickly after an event.
Fall in market for crops		1. Service Centre model gives training and flexibility to switch crops in response to market changes. 2. As far as possible farming should be under contract with agreed selling prices in place before sowing.
Water sources dry up		1. Water flows have been checked during the study and the risk is minimal. 2. In the unlikely event of this in several years' time, pumped provision from bore holes could be added.

16. Summary of recommendations

16.1 Demographic summary

The reality of climate change and its devastating effects on the lives of smallholder farmers demands that investment be made in irrigation in order to mitigate the effects, provide food security and give hope for improved incomes.

The analysis of the schemes is summarized in table 16.1 below and then the breakdown of costs is in Table 15.2.

Table 16.1 Scheme analysis summary

Scheme	Area (Ha)	Female farmers	Male Farmers	Total Farmers	Total family size
Bethani	28	52	108	160	1312
Chagumukire	45	56	87	143	1173
Tambako	40	47	73	120	984
Tapukwa	27	39	64	103	845
Kasengendule	8	14	25	39	320
Mbulakusamba	7	10	15	25	205
Lumbwezi	30	53	75	128	1050
Chivungulu	36	60	115	175	1435
Chayina	30	16	24	40	328
Chankhama	36	54	120	174	1427
Mphande	10	24	84	108	886
Totals	276	425	790	1215	17225

16.2 Refurbishment costs summary

Detailed Bills of Quantities have been prepared. The summary is based on an exchange rate of £1 = MK900.

Table 16.2 Summary of refurbishment costs (£ sterling)

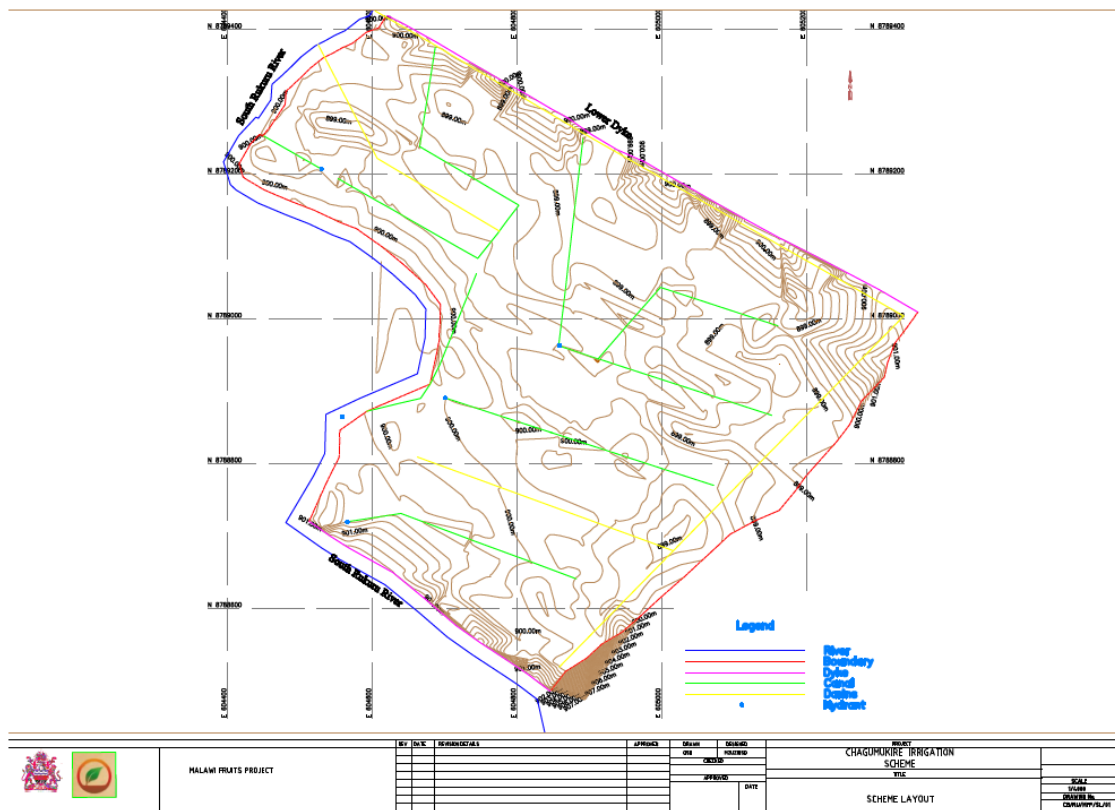
Scheme	Distribution network costs	Solar pump costs	Oversight of construction	Total costs	Cost per Hectare
Bethani	42425	n/a	2727	45152	1613
Chagumukire	30552	81887	2727	115166	2559
Tambako	11640	81887	2727	96254	2406
Tapukwa	11503	n/a	2727	14230	527
Kasengendule	11216	n/a	2727	13943	1743
Mbulakusamba	15508	n/a	2727	18235	2605
Lumbwezi	18709	n/a	2727	21436	715
Chivungulu	21561	81887	2727	106175	2949
Chayina	11700	n/a	2727	14427	481
Chankhama	20281	n/a	2727	23008	639
Mphande	22919	n/a	2730	25646	2565
Totals			30000	493672	

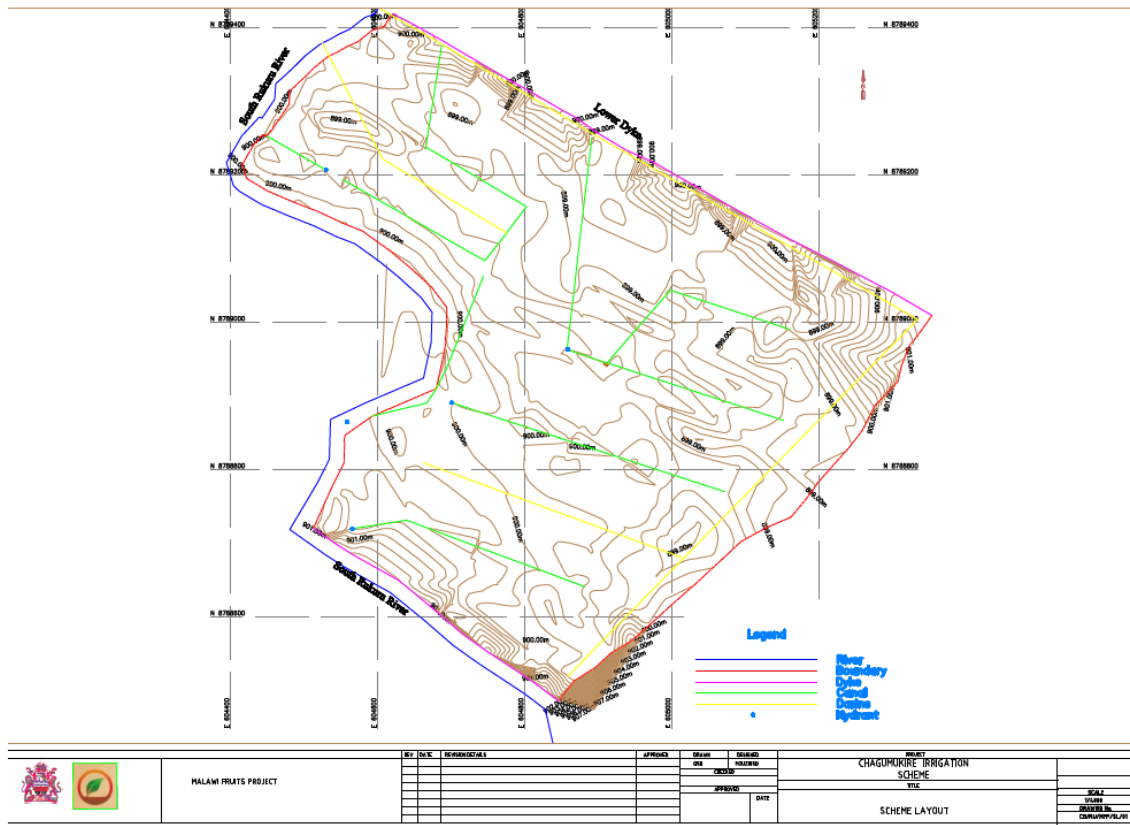
16.3 Recommendations

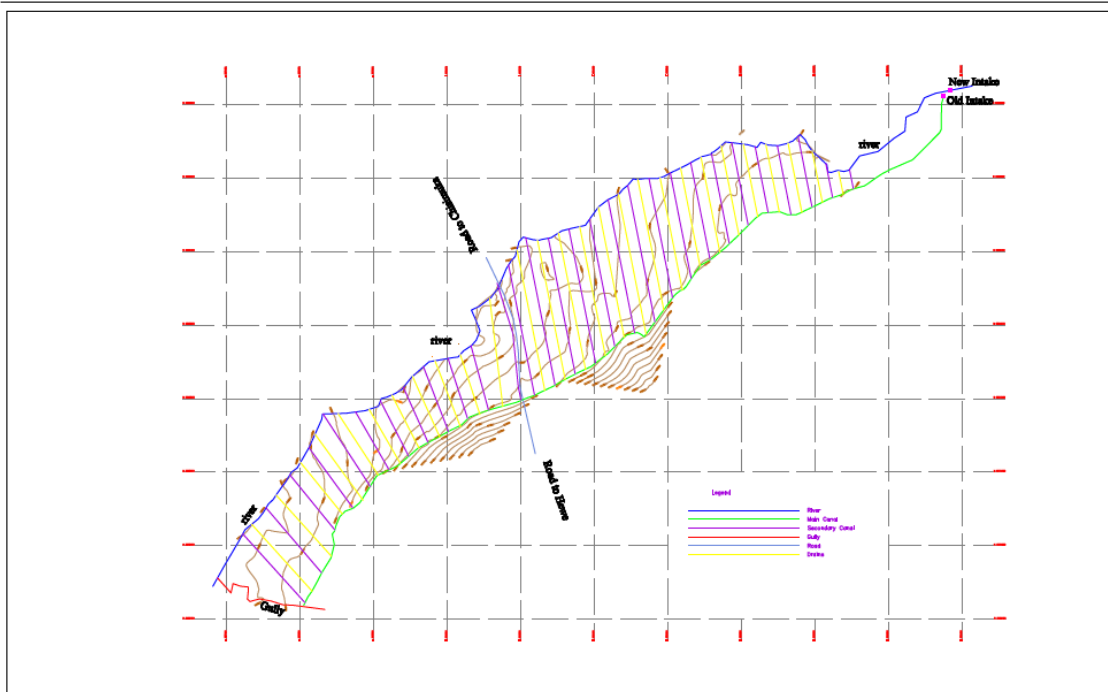
It must be remembered that this Study has focused on failed irrigation schemes – the reasons for their failure have been explored within this report. Close management of the refurbishment work is essential to deal with some of these failings but in order to ensure that the irrigated land realizes its full potential for the farmers, it will be necessary to include within a refurbishment project the costs of capital investment in mechanization (£54,000); the operational costs of the Service Centre for the first year (£37600); and a budget for loans for farmers for seeds (£10 per hectare). Even with these on-costs, the cost per hectare of the most expensive scheme is around £3500. As a benchmark, a recent (2016) solar irrigation project installed by Christian Aid in the South of Malawi cost £10,000 per hectare which implies that restoration is a much more cost effective option.




Implementation of this project could be incremental but the Service Centre concept will only be sustainable for at least 150 hectares.

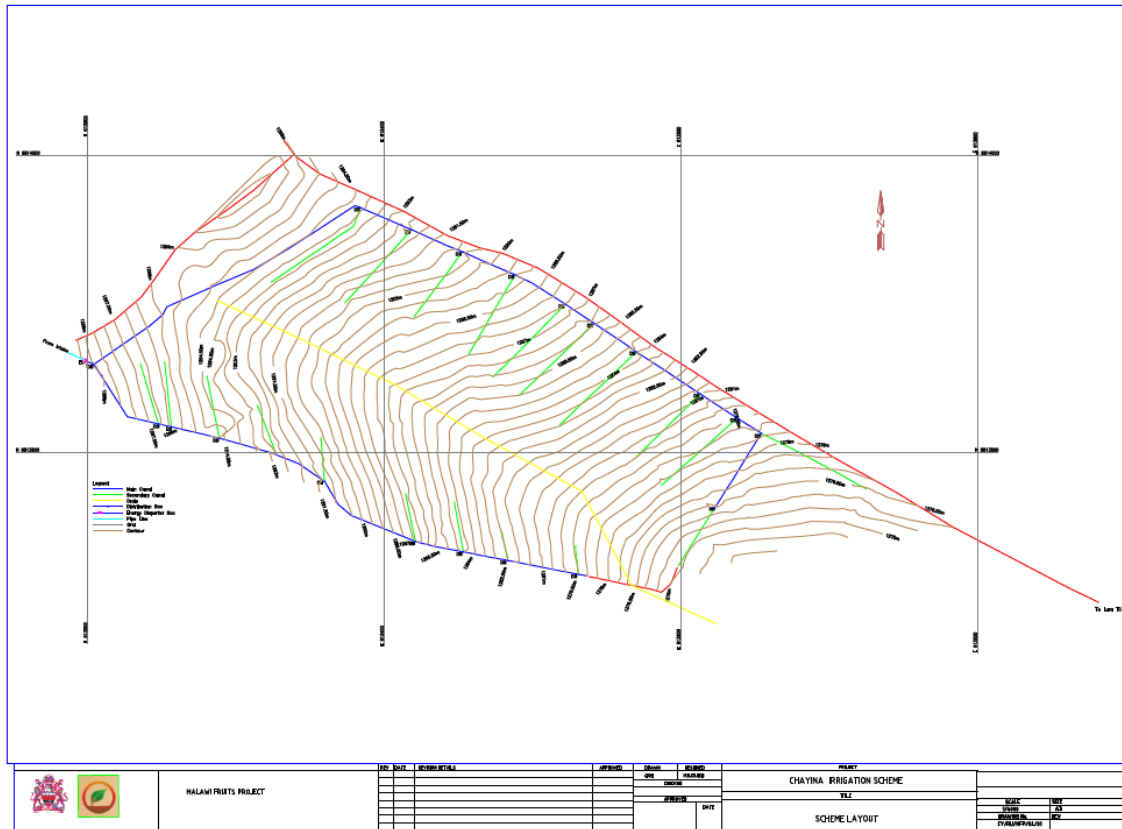
Appendix 1 - Irrigation Scheme drawings

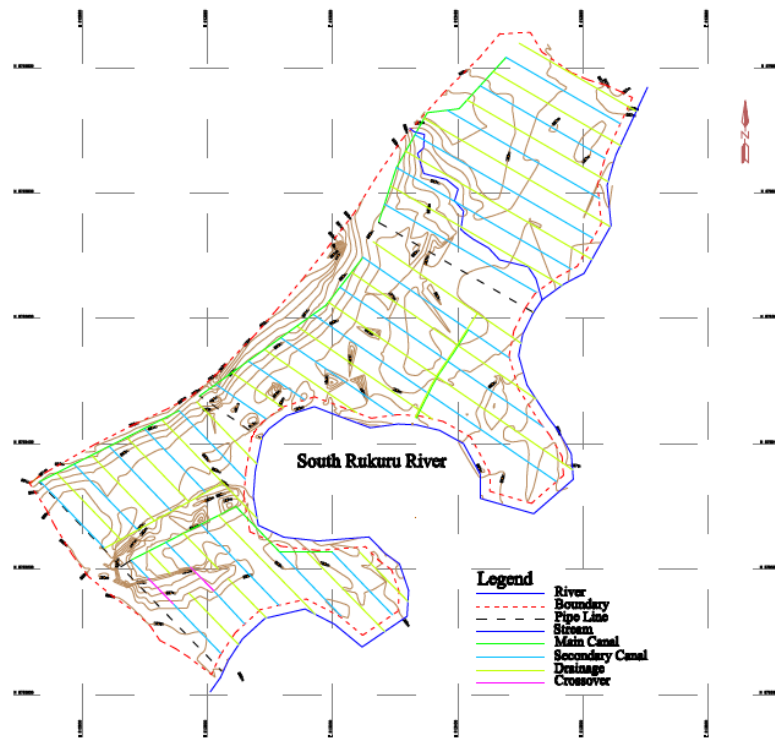






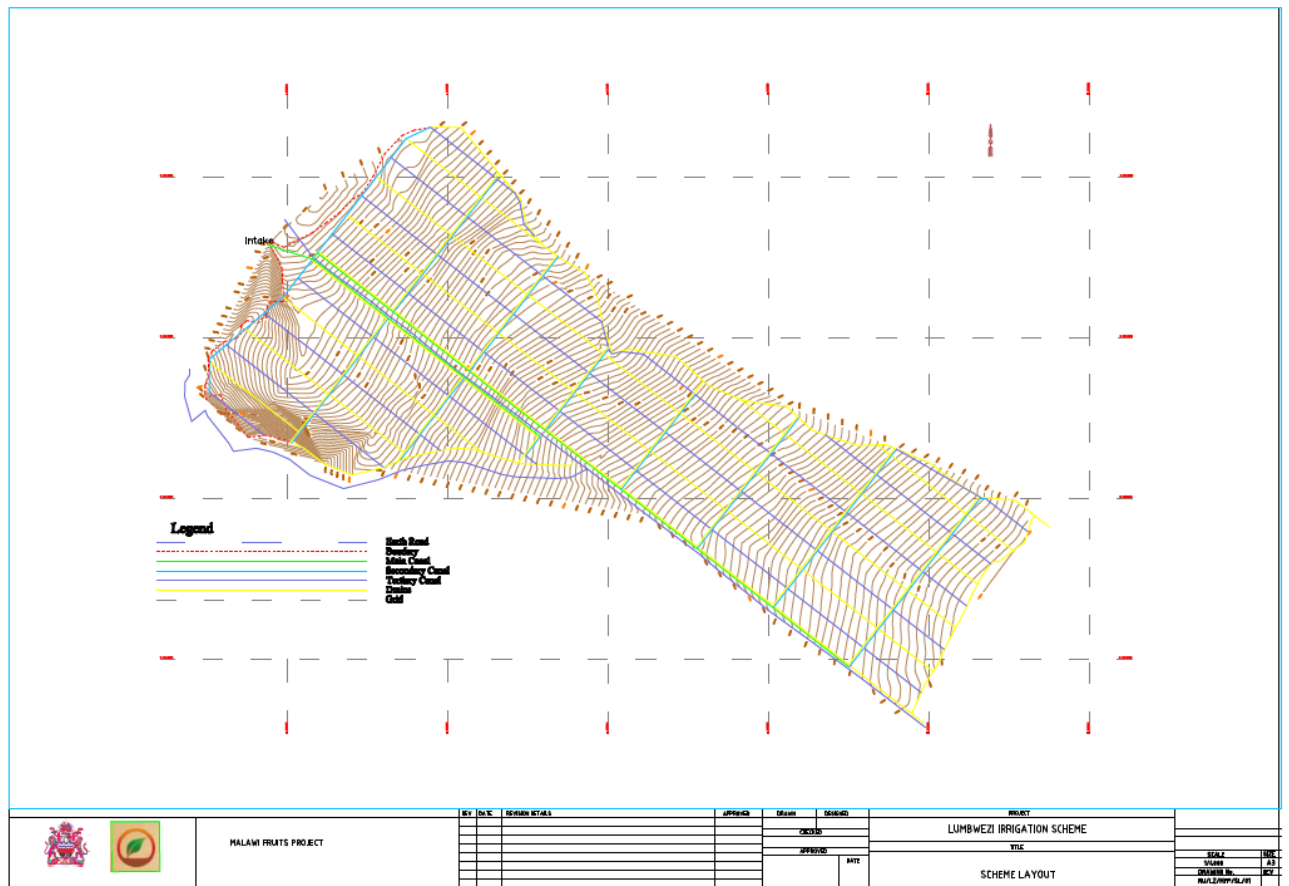


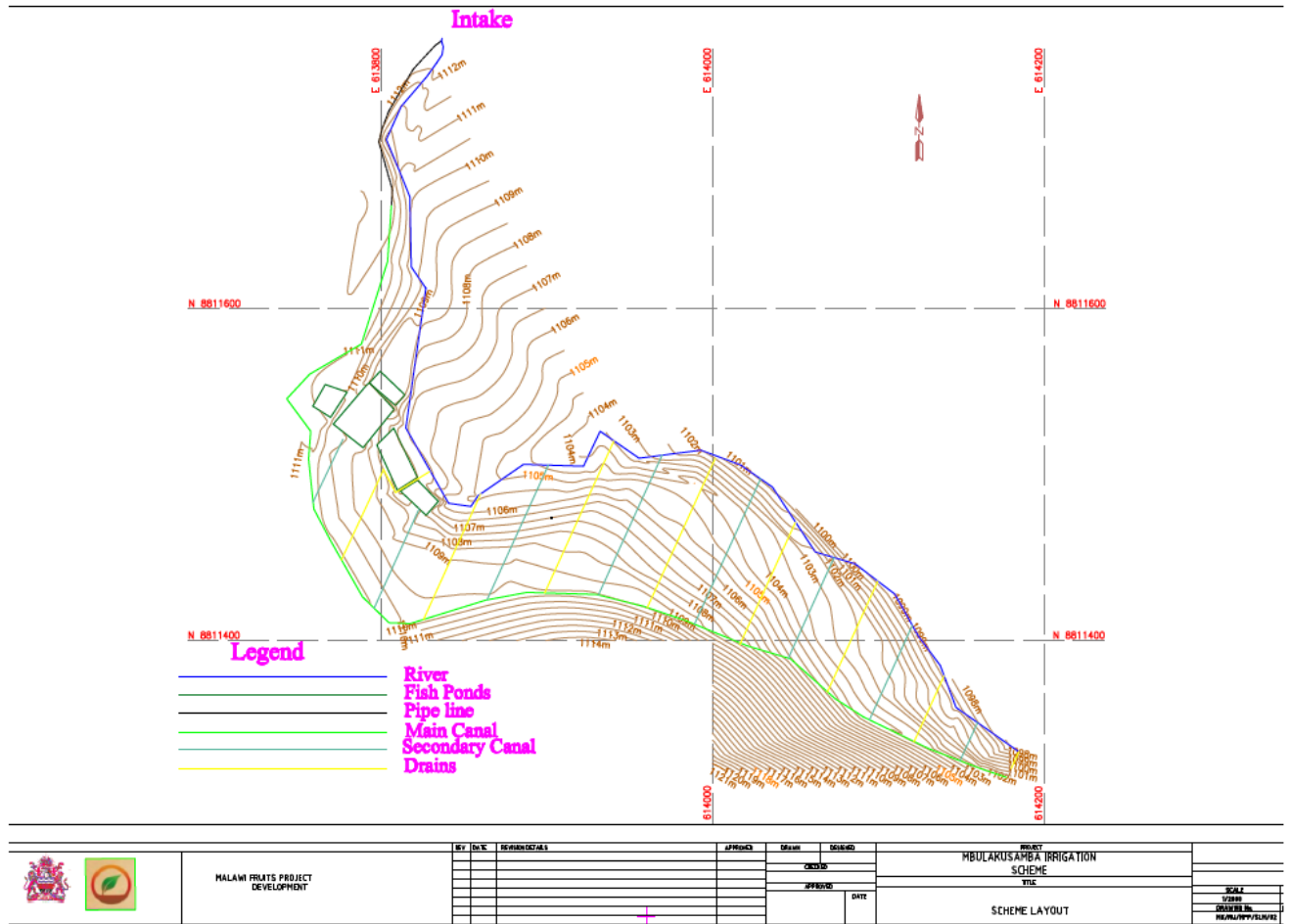
 	MALAWI PRATS PROJECT	BY DATE	REVISIONS	APPROVED	DATE	REVISION	REMARKS				
						APPROVED	DATE	CHANGHAMIA IRRIGATION SCHEME			
								TITLE			
								SCHEME LAYOUT			

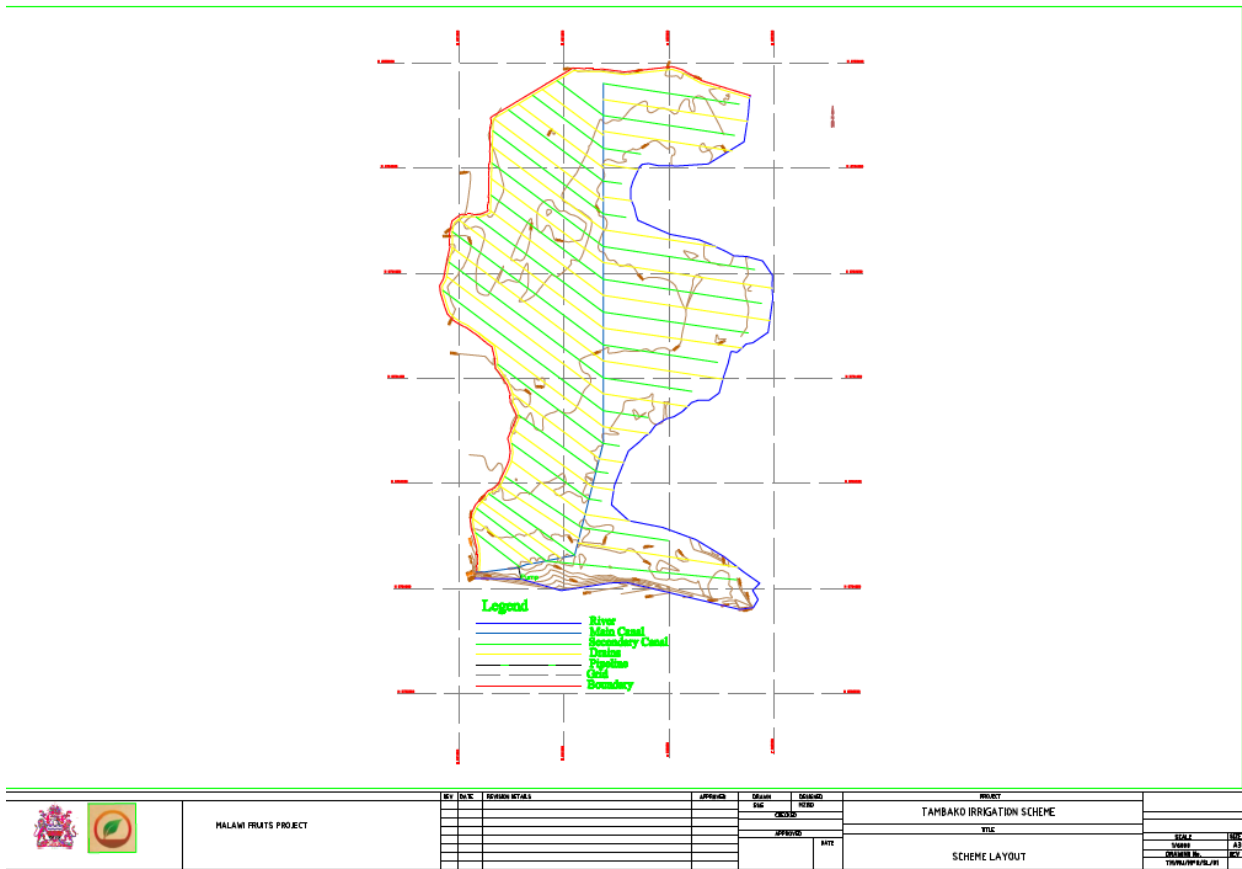




 	MALAWI PRIVATE PROJECT	REV	DATE	REVISIONS	APPROVED	DESIGN	DATE	PROJECT			
							10/07/2016	CHIVUNGULU IRRIGATION SCHEME			
							CHECKED				
							APPROVED				
										TITLE	SCALE
										SCHEME LAYOUT	DATE
											20/07/2016
											20/07/2016
											20/07/2016







Appendix 2 - Irrigation schemes soil & water analysis



MALAWI GOVERNMENT

MINISTRY OF AGRICULTURE, IRRIGATION AND WATER DEVELOPMENT
 DEPARTMENT OF AGRICULTURAL RESEARCH SERVICES
 LUNYANGWA AGRICULTURAL RESEARCH STATION
 P.O. BOX 59
MZUZU
MALAWI

Telephone: 01-310687/ 01-312962 / 01-310016
Fax: 01-310687/01310016
E-mail: lunyangwasoilslab@gmail.com



MOAIWD

Customer Name: Malawi Fruits
Address : _____
Telephone No. : _____
Email address : _____

24 January, 2016

SOIL ANALYSIS REPORT FOR MALAWI FRUITS

This is to report on the analysis of the soil samples which were collected from the seven irrigation schemes in Rumphi district. These schemes were Chivungulu, Bethani, Ntchenachena, Tapukwa, Lumbwezga, Chankhama and Mbulakusamba. The exercise was sponsored by Malawi fruits, an NGO which would like to revamp the schemes in the district.

The purpose of the analysis was to know the fertility status of the soils of the schemes so that problems faced by farmers in terms of soil fertility are addressed accordingly.

Soil sampling was done by Mr. Chisambi, and Mr. B. Kitta soil scientist and research attendant respectively, both from Lunyangwa agricultural research station, soils section. About 244 samples were collected for analysis for the following parameters; total nitrogen (%), Phosphorous ($\mu\text{g/g}$), Potassium (cmol/kg), Organic matter and total carbon (%), soil pH (H_2O), Calcium (cmol/kg), Magnesium (cmol/kg) and electric conductivity.

All the parameters were analysed at Lunyangwa agricultural research station soil laboratory in Mzuzu city.

Below are the results and recommendations for each and every scheme. The results of each and every sample have been written and at the bottom of the column an average has been indicated on which the recommendation has been based.

At the end of the paper, there is an appendix on which threshold for each and every element apart from electric conductivity has been written.

A. RESULTS INTERPRETATION AND RECOMMENDATIONS FOR LUMBWEZI IRRIGATION SCHEME BASED ON AVERAGE

INTERPRETATION	RECOMMENDATIONS	CROPS WHICH CAN DO BETTER IN THE SCHEME
Nitrogen (N) = 0.08 = Low	92Kg of nitrogen is needed/ha.	<ol style="list-style-type: none"> 1. Pineapples 2. Common Beans 3. Apples 4. Vegetables 5. Potato 6. Wheat 7. Pumpkins 8. Coffee 9. Macadamia 10. Bananas 11. Melons 12. Avocado pears
Phosphorous (P)= 55.89 = very high.	0.00 Kg of Phosphorous is needed/ha	
Potassium (k)= 0.13cmol/kg = Medium	10 kg of potassium is needed/ha	
Soil p H(H ₂ O) = 5.36 = Acid	The soil is acidic. Therefore, 2 tonnes/ha of lime is needed	
Total Carbon (TC) = 1.75% = Medium	It is okay. However, do not burn the crop residues. Incorporate in the soil.	
Organic Matter (OM) = 3.02% = Medium	Farmers should not burn the crop residues. Instead they should incorporate in the soil.	
Calcium (Ca) = 3.98 cmol/kg = High	No need of Calcium fertilizer e.g. CAN	
Magnesium (Ma) = 1.22 cmol/kg = High	No need of Magnesium application.	

B. RESULTS INTERPRETATION AND RECOMMENDATIONS FOR CHAYINA IRRIGATION SCHEME BASED ON AVERAGE

INTERPRETATION	RECOMMENDATION	CROPS WHICH CAN DO BETTER
Nitrogen(N)= 0.11% = Low	The scheme needs 92 kg of nitrogen/ha	This place is acidic and cool. Crops which can do better include: 1. Apples 2. Pineapples 3. Bananas 4. Potato 5. Beans 6. Vegetables 7. Pumpkins 8. Coffee 9. Wheat 10. Avocado pears
Phosphorous (P)= 61.65 ug/g= very high	No need of phosphorous application. It is more than enough	
Potassium (K)= 0.24cmol/kg=Medium	About 10 kg of potassium/ha is needed.	
Soil p H (H ₂ O)= 5.62 = moderately acid	About 2 tonnes of lime/ha is required	
Total Carbon (TC)= 1.24% = Medium	Crop residues incorporation should continue	
Organic Matter (OM)= 2.14% = Medium	Good. But crop residues should not be burned. Incorporate them into the soil	
Calcium (Ca)= 4.81 cmol/kg= High	No need for Calcium application (CAN)	
Magnesium (Mg)=1.63 cmol/kg= High	No need for Magnesium application	
Electric Conductivity (EC)=		

C. RESULTS INTERPRETATION AND RECOMMENDATIONS FOR CHANKHAMA IRRIGATION SCHEME

INTERPRETATION	RECOMMENDATION	Crops to be grown
Nitrogen(N) = 0.10 % = Low	92 kg/ha of nitrogen is needed to supply the deficit	Maize Beans
Phosphorous (P) = 87.92 ug/g = Very high	No need for phosphorous application	Fruits such as Mangoes, Oranges, Bananas
Potassium (K)= 0.26 cmol/kg = Medium	At this level, 10 kg of Potassium is needed per hectare	Groundnuts Sugarcane Pumpkins
Soil p H (H ₂ O) = 6.24 = Slightly acid	No need for lime application	
Total Carbon (TC) = 1.11% = Medium	No burning of crop residues. Incorporation in the soil is needed	
Organic Matter (OM)=1.97% = Medium	No burning of crop residues	
Calcium (Ca)= 6.95 cmol/kg = High	No need of Calcium application	
Magnesium (Mg) =1.81 cmol/kg = High	No need of Magnesium application	
Electric Conductivity (EC)=		

D. RESULTS INTERPRETATION AND RECOMMENDATIONS FOR TAPUKWA IRRIGATION SCHEME

INTERPRETATION	RECOMMENDATION FOR MAIZE (STAPLE FOOD IN MALAWI)	OTHER CROPS TO BE GROWN
Nitrogen(N)= 0.087%= Low	92 kg of nitrogen per hectare is needed	Fruits such as oranges, Guavas, Bananas Beans and potatoes Maize will do better only to the lower part.
Phosphorous (P)= 33.25 ug/g= High	No need for phosphorous application	
Potassium (K)= 0.27 cmol/kg=Medium	10 kg of Potassium is needed per hectare	
Soil p H (H ₂ O)=5.79= Moderately acid	2 tonnes of dolomite lime should be applied per hectare	
Total Carbon (TC)= 1.02% =Medium	Crop residues incorporation should be done	
Organic Matter (OM)= 1.73% = Medium	No burning of crop residues	
Calcium (Ca)= 6.54 cmol/kg= High	No need of Calcium application of lime	
Magnesium (Mg)= 0.90 cmol/kg= High	No need of Calcium application	
Electric Conductivity (EC)=		

E. RESULTS INTERPRETATION AND RECOMMENDATIONS FOR CHIVUNGULU IRRIGATION SCHEME

INTERPRETATION	RECOMMENDATION	CROPS WHICH CAN GROW BETTER
Nitrogen(N)= 0.093%= Low	92 kg of nitrogen per hectare is needed for Maize.	<p>In this scheme soil pH is good which means many crops can grow. But to the upper side, the problem is the soil texture is not friable.</p> <ol style="list-style-type: none"> 1. Maize 2. Banana to the lower side 3. Sweet Potato to the lower sides 4. Oranges and guavas 5. Vegetables 6. Mangoes
Phosphorous(P)=187.79 ug/g= Very high	No need of phosphorous application	
Potassium (K)= 0.31 cmol/kg= Medium	10 kg of potassium is needed per hectare	
Soil p H (H ₂ O)= 5.82= Slightly acid	2 tonnes of dolomite is needed/ha	
Total Carbon (TC)= 1.12%= Medium	Crop residues should be incorporated in the soil	
Organic Matter (OM)= 2.01% = Medium	Crop residues should be incorporated in the soil	
Calcium (Ca)= 8.20 cmol/kg = High	No need of Ca application	
Magnesium (Mg)= 2.85 cmol/kg = High	No need for application	
Electric Conductivity (EC)=		

F. RESULTS INTERPRETATION AND RECOMMENDATIONS FOR BETHANI IRRIGATION SCHEME BASED ON AVERAGE

INTERPRETATION	RECOMMENDATION	CROPS TO BE GROWN
Nitrogen(N)=0.09%= Low	92 kg of N is needed per hectare	1. Maize (the best) 2. Groundnuts 3. Beans 4. Vegetables 5. Oranges, Guavas, Mangoes.
Phosphorous (P)=56.34 ug/g= High	No need for Phosphorous application	
Potassium (K)= 0.34 cmol/kg= Medium	10 kg of potassium per hectare is needed	
Soil p H (H ₂ O)= 6.76= Almost neutral	No need for lime application	
Total Carbon (TC)= 1.09%= Medium	Incorporation of crop residues is needed	
Organic Matter (OM)=1.91%= Medium	Incorporation of crop residues is needed	
Calcium (Ca)=9.35cmol/kg= High	No need for Calcium fertilizer application	
Magnesium (Mg)=2.96 cmol/kg= High	No need for Magnesium application	
Electric Conductivity (EC)=		

G. RESULTS INTERPRETATION AND RECOMMENDATIONS FOR MBULAKUSAMBA IRRIGATION SCHEME

INTERPRETATION	RECOMMENDATION	CROPS WHICH CAN GROW IN RELATION TO SOIL pH
Nitrogen(N) = 0.10% = Low	92kg of nitrogen is needed/ha	<ol style="list-style-type: none"> 1. Maize 2. Beans 3. Bananas 4. Vegetables 5. Irish Potato or Sweet Potatoes 6. Fruits like Bananas, Pineapples 7. Groundnuts
Phosphorous (P) = 157.21ug/g= Very high	No need for application	
Potassium (K) = 0.14 cmol/kg = Medium	10 kg of potassium/ha	
Soil p H (H ₂ O) = 5.93 = Slightly acid	No need for application	
Total Carbon (TC) = 1.74% = Medium	Incorporation is needed	
Organic Matter (OM) = 3.00% = Medium	Incorporation is needed	
Calcium (Ca) = 3.51cmol/kg = high	No need for application	
Magnesium (Mg) =1.29 cmol/kg = high	No need for application	
Electric Conductivity (EC)=		

APPENDIX

Threshold Values

The above interpretations are with accordance to the following threshold values;

<u>Phosphorus $\mu\text{g g}$</u>	<u>Rating</u>
< 8	very low
9 – 18	low
19 - 25	medium (adequate range)
25 - 33	high (adequate range)
> 34	very high

<u>Potassium cmol/kg</u>	<u>Rating</u>
< 0.05	very low
0.06 - 0.10	low
0.11 - 0.40	medium (adequate range)
0.50 - 0.80	high
> 1.00	very high

<u>Total Nitrogen %</u>	<u>Rating</u>
< 0.08	Very low
0.08 - 0.12	Low
0.12 - 0.20	Medium
0.20 - 0.30	High
> 0.30	Very high

<u>Magnesium cmol/kg (Mehlich 3)</u>	<u>Rating</u>
<0.2	Very low
0.2 - 0.5	Low
0.6 - 3.0	High
>4.0	Very high

NB: Critical levels for Mn is 3.0 $\mu\text{g/g}$ and Ca is 2.0 cmol/kg using Mehlich 3 (Mehlich, 1984).

<u>Soil pH</u>	<u>Rating</u>
< 4.5	Very strongly acid
4.5 - 5.0	Strongly acid
5.1 - 5.5	Acid
5.6 - 6.0	Moderately acid
6.1 - 6.5	Slightly acid
6.6 - 7.0	Almost neutral
7.1 - 7.5	Very slightly alkaline

7.6 - 8.0	Slightly alkaline
> 8.0	Alkaline
>8.5	Strongly alkaline

% Carbon	Organic matter%	Rating
< 0.88	1.5	Low
0.88 - 2.35	1.5 - 4.0	Medium
> 2.35	> 4.0	High



MINISTRY OF AGRICULTURE IRRIGATION & WATER DEVELOPMENT

(WATER QUALITY SERVICES DIVISION)

LAB No.	1269	1270	1271	1272
DATE SAMPLED	9/12/15	9/12/15	9/12/15	9/12/15
SOURCE TYPE/LOCATION	Tapukwa Irr. Scheme Intake, TA Mwachenga, Rumphu	Tambalawoyera Irr. Scheme Intake, TA Mwalweni, RU	Mbulakusamba Irr. Scheme, TA Mwalweni, RU	Lumbwezi Irr Scheme Intake/China Irr Scheme Intake, TA Mwalweni, RU
pH Value	7.26	7.25	7.15	7.21
CONDUCTIVITY ($\mu\text{S}/\text{cm}$ at 25°C)	52	24	27	29
TOTAL DISSOLVED SOLIDS, mg/l	31	14	16	17
CARBONATE (as CO_3^{2-}), mg/l	0	0	0	0
BICARBONATE (as HCO_3^{-}), mg/l	16	5	6	7
CHLORIDE (as Cl^{-}), mg/l	5.1	2.23	3.8	3.9
SULPHATE (as SO_4^{2-}), mg/l	5.42	4.44	3.18	3.28
NITRATE (as NO_3^{-}), mg/l	0.127	0.171	0.070	0.037
FLUORIDE (as F^{-}), mg/l	-9	-9	-9	-9
SODIUM (as Na^{+}), mg/l	4.0	2.0	3.0	3.0
POTASSIUM (as K^{+}), mg/l	1.0	0.5	0.9	0.6
CALCIUM (as Ca^{++}), mg/l	3.9	1.6	1.1	1.4
MAGNESIUM (as Mg^{++}), mg/l	1.4	0.7	0.7	0.9
IRON (Fe^{++}), mg/l	0.293	0.144	0.199	0.137
MANGANESE (Mn^{++}), mg/l	-9	-9	-9	-9
TOTAL HARDNESS (as CaCO_3), mg/l	16	7	6	7
TOTAL ALKALINITY (as CaCO_3), mg/l	13	4	5	6
SILICA (as SiO_2), mg/l	-9	-9	-9	-9
TURBIDITY, NTU	249	9.68	10.5	7.4
SUSPENDED SOLIDS, mg/l	19	6	8.0	4.0
PHOSPHATE (PO_4^{3-}), mg/l	0.037	0.031	0.039	0.009
FAECAL COLIFORM, Counts/100 ml	920	460	1120	320

***** -9: Not Determined

ANALYSIS CARRIED OUT BY CENTRAL WATER LABORATORY



MINISTRY OF AGRICULTURE IRRIGATION & WATER DEVELOPMENT

(WATER QUALITY SERVICES DIVISION)

LAB No.	1265	1266	1267	1268
DATE SAMPLED	7/12/15	7/12/15	7/12/15	8/12/15
SOURCE TYPE/LOCATION	Chigumukire Irr. Scheme Intake S. Rukuru River, TA Mwankhunikira, RU(Upper Chivungulo Irr Scheme)	Chivungulo Irr. Scheme Intake, S. Rukuru River, TA Mwahenga, RU	Bethani Irr. Scheme, Ruviri River, TA Chisovya	Chankhama Irr. Scheme Intake, Hewe River, TA Katumbi, RU
pH Value	8.86	7.94	7.88	7.30
CONDUCTIVITY ($\mu\text{S}/\text{cm}$ at 25°C)	88	106	92	74
TOTAL DISSOLVED SOLIDS, mg/l	53	64	56	44
CARBONATE (as CO_3^{2-}), mg/l	5	7	5	0
BICARBONATE (as HCO_3^{2-}), mg/l	22	29	26	29
CHLORIDE (as Cl^-), mg/l	8.69	7.77	7.3	5.49
SULPHATE (as SO_4^{2-}), mg/l	5.06	6.29	5.63	5.17
NITRATE (as NO_3^-), mg/l	0.08	0.089	0.088	0.176
FLUORIDE (as F^-), mg/l	-9	-9	-9	-9
SODIUM (as Na^+), mg/l	7	8	5	5
POTASSIUM (as K^+), mg/l	2.3	2.6	2.1	2.1
CALCIUM (as Ca^{++}), mg/l	6.6	7.9	7.6	5.9
MAGNESIUM (as Mg^{++}), mg/l	2.2	3	3.2	2
IRON (Fe^{++}), mg/l	0.222	0.219	0.220	0.342
MANGANESE (Mn^{++}), mg/l	-9	-9	-9	-9
TOTAL HARDNESS (as CaCO_3), mg/l	26	32	33	24
TOTAL ALKALINITY (as CaCO_3), mg/l	26	35	30	24
SILICA (as SiO_2) mg/l	-9	-9	-9	-9
TURBIDITY, NTU	11.9	16.8	21.9	4.5
SUSPENDED SOLIDS, mg/l	7.0	9	17	2
PHOSPHATE (PO_4^{3-}), mg/l	0.089	0.087	0.011	0.050
FAECAL COLIFORM, Counts/100 ml	3400	3700	1600	2920

***** -9: Not Determined

ANALYSIS CARRIED OUT BY CENTRAL WATER LABORATORY



Tel. No. 01312016
Tel. No: 01312016/01311646
Fax: 01312607

Regional Water office (N)
P/Bag 68,
Mzuzu

MINISTRY OF AGRICULTURE, IRRIGATION & WATER DEVELOPMENT

Ref No: WD/N/M/19

16th December, 2015

The Development Executive,
Malawi Fruits
P.O.Box 112
Mzuzu

Dear Sir/Madam,

LABORATORY REPORT ON WATER SAMPLES COLLECTED IN SOME IRRIGATION SCHEMES IN RUMPHI

Reference is made to the eight water samples that our personnel collected from irrigation schemes in Rumphi District according to your request. These Irrigation schemes are: Chigumukire in TA Mwankhunikira; Chivungulo and Tapukwa in TA Mwahenga; Bethani in TA Chisoyva; Chankhama in TA Katumbi; and Tambalawoyera, Mbulakusamba, Lumbwezi and China in TA Mwalweni. But Lumbwezi and China scheme have one intake hence one sample was collected. Water samples were collected from these schemes, from 7th to 9th December 2015, in order to determine the quality of water for irrigation purposes. But in most of the schemes it was noted that communities were also using the same water from the irrigation canals for drinking, and other domestic purposes, notably in Tapukwa and Tambalawoyera Irrigation Schemes. The proximity of the water source and non-availability of a protected water source in the area has been mentioned as the contributing factors. Due to this, reference of the obtained water quality results to the Guideline and National Water Standards, for constituents of health significance, MS214:2015, for drinking water, is made. And water fit for drinking is also fit for most other purposes, e.g. irrigation

Analysis of the water samples was conducted in accordance with the Standard Methods for the Examination of Water and Wastewater, 21st Edition, at Central Water Laboratory.

1.0 DISCUSSION ON THE LABORATORY TEST RESULTS

1.1 Microbiological Water Quality

- Faecal coliform type of bacteria, in this exercise was tested and the results ranged from 320 to 3700 coliform colony counts/100ml of water sample, far above the National Standard for drinking water of zero counts/100ml for untreated water. And this means communities, if they were consuming the water raw, were doing so at a risk of contaminating water borne diseases.

Faecal Coliform type of bacteria are detected and enumerated in water as "indicator bacteria" because these are bacteria which are always excreted in large numbers by warm blooded animals irrespective of whether they are health or sick. But the presence of these indicator bacteria in water is therefore indicative of faecal contamination of that water and this contamination suggests the potential presence of pathogens and thus a health hazard.

Suggested faecal coliform density of not more than 100 colonies/100ml if the water is to be used for unrestricted irrigation (*Water, Wastes and Health in Hot Climates*) is accepted

1.2 Chemical and Physical Water Quality

The water quality parameter of major importance in irrigation water is salinity, as measured by electrical conductivity (EC) or total dissolved solids (TDS) which seriously affects crop growth when present in high concentration.

EC is a measure of the ability of an aqueous solution to carry an electric current. This ability depends on the presence of ions; on their total concentration, mobility, and valence and on the temperature of the measurement. The samples collected registered very low TDS and EC; with TDS ranging from 14 mg/l to 64mg/l and EC ranging from 24 μ s/cm to 106 μ s/cm an indication of low ionic activity of the sampled waters.

Chemically and physically most sampled sources had waters fit for human consumption according to Malawi National Water Guideline standards for drinking water MS214:2005. And the gardens were well drained with some with adequate water supply and others not well supplied but the intake with plenty water.

2.0 REMARK(S)/RECOMMENDATION(S)

- Spray water type of irrigation being practiced at Chivungulo at times be discouraged, for vegetables that are eaten raw, due to high coliform counts registered in the water sample
- Communities be discouraged from drinking raw water collected, out of desperation, from the water canals. If they are to drink the water they be encouraged to treat the water at household level, either chemically or by boiling.

- If funds are available to assist the community with piped water system, then the intake for the drinking water source be shifted upwards to a point where there are no human settlements and activities.
- Chemical results have shown that the waters in all schemes were fit for irrigation purposes though consideration be made on high faecal coliform counts registered.

Please feel free to contact this office should you need more clarification in the laboratory test results provided.

Yours faithfully,



Ambrose Phiri
SENIOR WATER CHEMIST/WATER QUALITY SERVICES
For/REGIONAL WATER OFFICER (N)

Attached: *Tables of results*

Appendix 3 - Irrigation schemes Bills of Quantities Summaries

BETHANI IRRIGATION SCHEME			
BILL SUMMARY			
Bill NO.	DESCRIPTION	AMOUNT (MK)	
1	Crossovers	667,161.00	
2	Weir	444,382.40	
3	Distribution boxes	2,916,696.00	
4	Secondary canal	4,368,912.41	
5	Tertiary canal	26,271,662.04	
6	Tools	242,500.00	
7	Supervision	709,000.00	
	SUB TOTAL	35,620,313.85	
	10% Contingency	3,562,031.38	
	GRAND TOTAL	39,182,345.23	

CHAGUMUKIRE IRRIGATION SCHEME			
BILL SUMMARY			
Bill NO.	DESCRIPTION	AMOUNT (MK)	
1	Flood protection bund	7,463,346.00	
2	Solar pump and accessories	73,698,000.00	
3	Distribution boxes	1,400,014.08	
4	Secondary canal	967,286.88	
5	Tertiary canal	13,927,804.20	
6	Tools	288,500.00	
7	Supervision	950,000.00	
	SUB TOTAL	98,694,951.16	
	10% Contingency	9,869,495.12	
	GRAND TOTAL	108,564,446.28	

TAMBAKO IRRIGATION SCHEME			
BILL SUMMARY			
Bill NO.	DESCRIPTION	AMOUNT (MK)	
1	Cross over and flood protection bund	3,536,346.00	
2	Solar pump and accessories	73,698,000.00	
3	Distribution boxes	1,616,415.36	
4	Secondary canal	3,385,504.08	
5	Drains	367,200.00	
6	Tools	288,500.00	
7	Supervision	330,000.00	
	SUB TOTAL	83,222,298.44	
	10% Contingency	8,322,229.84	
	GRAND TOTAL	91,544,528.28	

Tapukwa IRRIGATION SCHEME			
BILL SUMMARY			
Bill NO.	DESCRIPTION	AMOUNT (MK)	
1	Crossovers	1,392,239.20	
2	Weir	559,520.50	
3	Distribution boxes	437,504.40	
4	Secondary canal	3,869,147.52	
5	Tertiary canal	2,048,206.50	
6	Tools	352,500.00	
7	Supervision	753,000.00	
	SUB TOTAL	9,412,118.12	
	10% Contingency	941,211.81	
	GRAND TOTAL	10,353,329.93	

KASENGENDULE IRRIGATION SCHEME			
BILL SUMMARY			
Bill NO.	DESCRIPTION	AMOUNT (MK)	
1	Crossovers	406,848.20	
2	Weir	882,255.00	
3	Distribution boxes	379,170.48	
4	Main canal	1,637,334.56	
5	Secondary canal	4,792,803.21	
6	Tools	327,500.00	
7	Supervision	751,000.00	
	SUB TOTAL	9,176,911.45	
	10% Contingency	917,691.15	
	GRAND TOTAL	10,094,602.60	

Mbulakusamba IRRIGATION SCHEME			
BILL SUMMARY			
Bill NO.	DESCRIPTION	AMOUNT (MK)	
1	Crossovers	274,848.20	
2	Weir	1,500,633.75	
3	Distribution boxes	3,500,035.20	
4	Main canal	2,015,181.00	
5	Secondary canal	4,260,269.52	
6	Tools	327,500.00	
7	Supervision	810,000.00	
	SUB TOTAL	12,688,467.67	
	10% Contingency	1,268,846.77	
	GRAND TOTAL	13,957,314.44	

LUMBWEZI IRRIGATION SCHEME			
BILL SUMMARY			
Bill NO.	DESCRIPTION	AMOUNT (MK)	
1	Crossovers	2,559,658.20	
2	Weir	655,008.75	
3	Distribution boxes	2,916,696.00	
4	Secondary canal	1,609,625.82	
5	Tertiary canal	6,144,619.50	
6	Tools	327,500.00	
7	Supervision	1,094,000.00	
	SUB TOTAL	15,307,108.27	
	10% Contingency	1,530,710.83	
	GRAND TOTAL	16,837,819.10	

CHIVUNGULU IRRIGATION SCHEME			
BILL SUMMARY			
Bill NO.	DESCRIPTION	AMOUNT (MK)	
1	Flood protection bund	4,399,747.00	
2	Solar pump and accessories	73,698,000	
3	Distribution boxes	904,175.76	
4	Secondary canal	9,338,036.70	
5	Tertiary canal	1,720,493.46	
6	Tools	273,500.00	
7	Supervision	1,005,000.00	
	SUB TOTAL	91,338,951.46	
	10% Contingency	9,133,895.15	
	GRAND TOTAL	100,472,846.61	

CHAYINA IRRIGATION SCHEME			
BILL SUMMARY			
Bill NO.	DESCRIPTION	AMOUNT (MK)	
1	Crossovers	735,004.60	
2	Weir	1,195,810.00	
3	Distribution boxes	1,458,348.00	
4	Secondary canal	72,546.52	
5	Tertiary canal	5,325,336.90	
6	Tools	327,500.00	
7	Supervision	458,000.00	
	SUB TOTAL	9,572,546.02	
	10% Contingency	957,254.60	
	GRAND TOTAL	10,529,800.62	

CHANKHAMA IRRIGATION SCHEME		
BILL SUMMARY		
Bill NO.	DESCRIPTION	AMOUNT (MK)
1	Crossovers	782,172.60
2	Weir	4,108,350.00
3	Distribution boxes	1,282,000.00
4	Secondary canal	2,988,000.00
5	Main Canal	5,081,400.00
6	Tools	142,000.00
7	Supervision	2,210,000.00
	SUB TOTAL	16,593,922.60
	10% Contingency	1,659,392.26
	GRAND TOTAL	18,253,314.86

MPHANDE IRRIGATION SCHEME		
BILL SUMMARY		
Bill NO.	DESCRIPTION	AMOUNT (MK)
1	Crossovers	650,166.00
2	Weir	8,423,850.00
3	Distribution boxes	1,665,000.00
4	Secondary canal	6,401,600.00
6	Tools	121,000.00
7	Supervision	1,490,000.00
	SUB TOTAL	18,751,616.00
	10% Contingency	1,875,161.60
	GRAND TOTAL	20,626,777.60