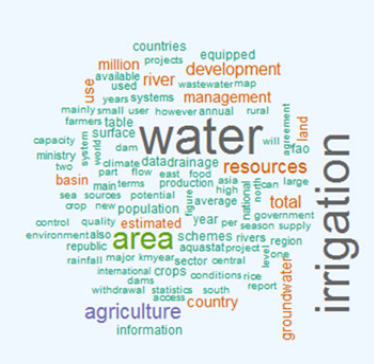

Irrigation Systems Inventory

Inception Report: Part 1/5 – Literature Review

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Report submitted to

welt hunger hilfe
For a world without hunger

14 Natal Road, Belgravia, Harare, Zimbabwe
Telephone: +263(4) 303864

Contact person: Ajay Paul
ajay.paul@welthungerhilfe.de
Cell phone: +263(77) 2406251

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Agricultural Inputs Supply Programme (AISP)
1 Orange Grove Drive, Highlands, Harare, Zimbabwe

Contact person: Michael Glueck
michael.glueck@giz.de
Cell phone: +263(77) 7282510

Report submitted by

11 Hodson Avenue, Alexandra Park,
Harare, Zimbabwe
Telephone: +263(4) 744559

Contact person: Michael Dawes
michael@apt.co.zw
Cell phone: +263(77)2212201

Contents

Executive summary

This report represents the first of five in the inception phase of the development of an Irrigation Scheme Inventory of smallholder irrigation schemes in Zimbabwe. It provides a review of international and local literature on the development of irrigation inventories. Many of the examples are from Asia (e.g. Indonesia, Philippines, Nepal) where national governments have made considerable investments in schemes. The **objectives** of inventories in the papers reviewed in this report include:

- Informing strategy development for national governments;
- Determining investment priorities for governments;
- Determining water allocation priorities; and
- Development priority needs to match policy.

This project seems to be unique in that the inventory is specifically developed as an investment tool for all potential investors – be they government, private sector or donors.

Irrigation scheme databases are usually developed by governments, often with the assistance of donor funds. **Ownership** of databases listed in the papers reviewed is often not explicitly documented, the assumption being that they are government owned. The main advantage of government ownership is that they usually have capacity to maintain such inventories which are unlikely to be profitable – the review turned up little information on database **sustainability**, perhaps because they are built for development objectives with little thought of cost recovery. It is noted that data collection and handling is expensive and requires significant resources and that returns on the investment in an irrigation inventory are indirect and not easily attributable and quantifiable.

The **procedures and methods** outlined in the reports under review provided good ideas and information for the current project. For example, Yoder (1992) described the development of data collection instruments designed to feed data into a computing system, and which solicit Boolean and pre-coded responses. Field visits need to be carefully planned and implemented with suitably qualified, trained and independent resource personnel. Data verification is important to ensure that the quality of information is maintained, and regular updating of the information is key for maintaining the usefulness of the information.

Data fields used in the reviewed literature are **categorised** into

- Material resources (water, land and infrastructure)
- Human resources (scheme demographics, structures and management, and agricultural productivity and marketing)

Within each of these categories there are comprehensive lists of fields that have been used in the inventories reported on in the studies. This information provides an excellent structure and resource for the next part of this ISI study when local stakeholders (including potential investors) will be asked to describe the type information that they would like to have access to in a database to guide investment decisions.

The ISI programme partially conforms to the needs of the Government of Zimbabwe, as identified in the literature under review. With its focus on investment opportunities, the ISI will not necessarily capture detailed information required by government which has different developmental requirements for a database.

In conclusion, this study provides a very good starting point for the ISI inception, informing all other programme components that are still to take place:

- Stakeholder mapping and interviews;
- Database structure development;
- Development of field survey methodology and field testing of instruments at irrigation schemes; and
- Development of a business model to outline costs and potential revenue streams.

Introduction

Agriculture contributes 15-20% to Zimbabwe's Gross Domestic Product, estimated at US$ 11.427 billion in 2012 (GOZ, 2012), and accounts for 40% of the nation's exports (GOZ, 2013a). The sector accounts for 25% of formal employment and provides livelihoods for over 70% of the rural population. The sector is central to the economy in guaranteeing food security and backward and forward linkage to markets. The agro-processing industry draws some 63% of its input requirements from agriculture (GOZ, 2013a).

The government of Zimbabwe has prioritised irrigation development since 1930 when it embarked on a national dam construction programme for large scale commercial farmers (GOZ, 2004). In a country where agriculture is dependent on a single rainy season (November through March) irrigation is an important strategy for increasing productivity through:

- Provision of supplementary water during mid-season dry spells, or seasonal droughts.
- Winter production of crops such as pulses (sugar beans), cereals (wheat) and horticulture.

In addition, access to irrigation allows farmers to explore the production of new, higher valued crops.

According to the World Bank (2013a), the country now has more than 8 000 dams which in 2000, commanded more than 120 000 ha of irrigation land[1]. The Fast Track Land Reform Programme that commenced in 2000, and the related decade-long period of economic decline, contributed to a reduction in this irrigated area. The same report estimates that in 2012 the area under irrigation was only 51 000 ha[2] (*ibid.*).

Government policy is to rehabilitate these idle irrigation schemes before developing new ones (e.g. GOZ, 2013b). It is estimated that about 200 000 ha can be developed from existing under-utilized storage capacity and dams under construction (World Bank, 2013b). Furthermore, the irrigation potential of the country is estimated at around 365 000 ha, considerably less than irrigable land, estimated at 600 000 ha (*ibid.*).

The Government of Zimbabwe continues to promote irrigated agriculture through various policy documents including the Medium Term Plan (GOZ, 2011), CAADP compact (GOZ, 2013c), Zimbabwe Agricultural Investment Programme (GOZ, 2013a), Zim-Asset (GOZ, 2013d) and most recently, the 2014 National Budget Statement (GOZ, 2013b).

Since independence in 1980 government has focused on irrigation development in communal farming areas, many of which are located in drought-prone regions. Over 180 smallholder schemes have since been developed on communal and old resettlement schemes commanding an area of 8103 ha (GOZ, 2004). A further 2000 ha have been developed on

[1] This value is based on satellite imagery. However estimates vary widely in the literature. For example, the ZAIP document (GOZ, 2013a) reports that 200 000 ha were irrigated in 2000

[2] See Footnote 1. The ZAIP report (GOZ, 2013a) estimates that 135 580 ha was under irrigation in 2009. World Bank (2013b) estimate that between 70 000 and 135 000 ha are currently being irrigated. The equivalent estimate in Zim-Asset (GOZ, 2013d) is 150 000 ha.

small scale commercial farms. Thus a total of up to 10000 ha of irrigation are available in the formal smallholder subsector (*ibid.*). One of the features of these schemes is that, for the most part, they are stuck in a recurring cycle of build, operate, decline and rehabilitation with the latter process usually being funded by government or international donors on a grant basis. To this end, government has allocated US$9.4 million for communal irrigation schemes in the 2014 budget, whilst the Swiss government recently provided a grant for the rehabilitation of Rupike and Pfuve Panganayi irrigation schemes in Masvingo Province. This cycle points to a lack of capacity of scheme beneficiaries to maintain their equipment. World Bank (2013a) note that a lack of technical capacity also extends to national institutions such as ZINWA.

According to World Bank (2013a), the restoration of irrigation infrastructure is necessary *but not sufficient* to restore irrigated agricultural production. Other constraints include uncertainties about land tenure, absence or dilapidated infrastructure, unreliable power supplies and weak input and output markets. They argue that past budgetary allocations by the Ministry of Finance have not been effectively used because of these constraints. There is thus a need to focus on 'software' (i.e. capacity) and market issues as well as the more obvious hardware limitations.

It is against this background that Welthungerhilfe (WHH) and GIZ through the Food Security and Agriculture Programme plan to develop methods and tools that will assist investors (private sector, government and donors) in making decisions on selection of irrigation schemes providing the best investment opportunities. WHH and GIZ have considerable experience in smallholder irrigation system development and the smallholder farming sector in Zimbabwe and throughout the developing world. These organisations have contracted Floranature, an agricultural consulting firm specialising in the smallholder farming sector, to develop the framework for an Irrigation Systems Inventory (ISI).

This report represents the first step towards this goal, documenting the international and local experience in developing irrigation scheme inventories.

Acronyms used in this report

Agritex	Department of Agricultural, Technical and Extension Services
DAD	Department of Agrarian Development
DOI	Department of Irrigation
EU	European Union
FAO	Food and Agricultural Organisation
FMIS	Farmer-managed irrigation systems, Nepal
GIS	Geographic Information System
GOZ	Government of Zimbabwe
ha	Hectare
IA	Irrigation Association
IMC	Irrigation Management Committee
IWMI	International Water Management Institute (a CGIAR institute)
IRDP	Integrated Rural Project Development Project, Sri Lanka
km	Kilometre
MIS	Community Managed Rehabilitation of Minor Irrigation Schemes Project, Sri Lanka
MIS	Management Information System
nd	No date
NGO	Non Governmental Organisation
O&M	Operation and Maintenance
PIO	Plan Implementation Officer
PSIP	Public Sector Investment Programme
ISI	Irrigation System Inventory
JICA	Japan International Cooperation Agency
SDC	Swiss Development Cooperation
UNDP	United Nations Development Programme
WB	World Bank
WFP	World Food Programme
WSIA	Water Sector Investment Analysis
WUA	Water Use Association
Zim-AIED	Zimbabwe Agricultural Income and Employment Development Programme
ZINWA	Zimbabwe National Water Authority

Local and international experience in developing similar inventories

Objectives, outputs and outcomes of inventories

An inventory can simply be defined as a list, prepared for easy access to information. Thus, data should be able to be sorted, arranged as needed before reports are printed (Yoder, 1992).

The literature describes numerous irrigation inventories that have been developed internationally for different purposes. Yoder (1992) lists these purposes as (1) to supply input for preparing an overall irrigation development strategy that does not overlook existing resources; (2) to set priorities for investment; (3) to determine water allocation priorities in a watershed; (4) to determine development priority needs to match policy strategy; (5) to provide first level identification of system deficiency; (6) to provide first level identification of systems, institutions and experience which can be used to expand, intensify and improve irrigated agricultures or that need to be modified for expansion; (7) to establish implementation priority that allows effective supervision; (8) to identify systems to use for demonstrating good irrigation management practices that can be used as sites for farmer-to-farmer training; and (9) to identify and classify problems that require research attention.

Some of these purposes are confirmed by Lauraya et al (1992) who list reasons for making an inventory of irrigation systems on a river basin as (1) to improve river basin level resource management; (2) to improve support services; (3) to improve irrigation management and (4) to select research sites.

In the following discussion, case studies are provided for some of the purposes outlined by these two authors. Often inventories have been developed for a combination of these reasons – where this is the case, the study is listed under the most appropriate heading.

Strategy development

The following case study from Tajikistan describes how an inventory can be used to implement a national strategy:

Irrigation Systems Inventory Methodology, Tajikistan

In Tajikistan, agriculture is based on irrigation schemes on about 750 000 ha (UNDP, 2013). Up until 1991, agriculture was organized in a dual system, in which large-scale collective (*kolkhoz*) and state (*sovkhoz*) farms coexisted with quasi-private individual farming on subsidiary household plots. The process of transition to a market economy that began in independent Tajikistan after 1992 led to the creation of a new category of midsized peasant farms, known as *dehkan* farms. As of 2006, around 25,000 peasant farms controlled 60% of arable land, or 530,000 hectares (the remaining 40% being split evenly between household plots and farm enterprises). These reforms resulted in infrastructure decline and the decision, in 2006, to shift the irrigation sector to hydro- geographic principles of management. In the process of this work, it became necessary to clarify such important issues as (1) avail-

ability of irrigation systems facilities; (2) ownership and technical conditions of irrigation systems facilities; and (3) funds required for rehabilitation. An inventory of capital assets of all irrigation systems based on a single methodology was designed to help answer these questions and promote the irrigation sector reform through creation of basin organizations and sustainably operating Water Use Associations (WUAs) in respective hydro-geographic units and further transition to the integrated water resources management.

The inventory, done annually, was also needed (1) to determine the need for planning and carrying out repair and maintenance works; (2) as a decision making tool for writing-off facilities that could not be restored; and (3) to determine the irrigated land area serviced by different facilities by their actual capacity, as well as land area connected with various irrigation systems facilities. Streamlining these issues would contribute to developing well-thought plans on water use and effective management of water and land resources within the limits of irrigation systems, mapping the location of *intra-farm* and *inter-farm* facilities and transferring them respectively to basin organizations and WUAs. The inventory resulted in the preparation of proposals for assigning facilities to relevant organizations (*ibid*.).

Relevance for the ISI
The objectives of the Tajikistan ISI – support for irrigation sector reform – are quite different to those of the current study. However in both cases there is a need to describe the conditions and capacity of irrigation schemes to inform investment decisions.

Investment priorities

The following case studies from Zimbabwe describe how inventories can be used to prioritize investments:

Water Sector Investment Analysis (WSIA), Zimbabwe

The WSIA, undertaken in Zimbabwe, provides useful insight for the current initiative (WB, 2013). The objective of WISA was to guide WB's future investment in the water sector and contribute towards the government's preparation of a water sector investment strategy. Although not focused on irrigation per se, the study objectives are similar to those of the ISI and can inform the development and sustainability of the ISI. One of the deliverables of this study was a database of water sector investment projects. The consultants who undertook the study were concerned about:

- Identifying the most appropriate institutional home for the database.
- Identifying the right people for training.
- Investing sufficient preparation and participatory delivery time into the training process.

Prioritizing investments in Masvingo, Zimbabwe

SDC (2010) and JICA (2003) describe inventories developed in Zimbabwe for the purpose of prioritizing investments. In the case of SDC (2010), the research was done to determine the identity of two irrigation schemes from a total of 10 with the greatest potential for market ori-

ented development. In both studies, assessments were made of infrastructure, management and market linkage issue). The existing condition of the irrigation infrastructure and facilities was described, with a view to assessing the level of deterioration from which priorities for rehabilitation will be determined.

Relevance for the ISI
These case studies are the most relevant for the development of a Zimbabwean ISI. The first (WB, 2013) highlights the importance of investing in the development of the capacity of the government departments that will assume responsibility of the database. The objectives of the study commissioned by SDC (2010) are closely aligned to the current initiative, providing useful methodologies and lists of variables to include in a checklist.

Development priority needs

The following case studies from Indonesia and Philippines describe how inventories can be used to prioritize development needs:

Inventorying irrigation schemes in Indonesia

According to Pitana (1992), the objective of developing an inventory for Bali in Indonesia was to describe the social-institutional and physical characteristics of the irrigation schemes so as to assess the need for further development and management planning. This pilot would have the added advantage of producing a tested method for inventorying irrigation systems throughout Bali, where the predominant crop is irrigated rice.

Pilot inventory of communal irrigation schemes in the Philippines

Ibabo (1992) report on an inventory of communal irrigation systems in the Capiz Province of the Philippines undertaken with the objectives of (1) making a realistic (but rapid) field level assessment and evaluation of the status, both technical (physical profile and functionality) and institutional (organizational, management and financial status); and (2) verifying monitoring data (e.g. area, number of beneficiaries, number of structures). The study also hoped to establish benchmark information for these systems.

Relevance for the ISI
The determination of development needs is important for the ISI, because it will help in the understanding of the capacity of farmers to engage in commercial activities. Methodology used

Identification of system deficiency

The following case studies from Sri Lanka describe how inventories can be used to prioritize development needs:

Integrated Rural Project Development Project (IRDP), Sri Lanka

The IRDP in Sri Lanka began with an emphasis on upgrading and rehabilitating infrastructure at minor irrigation schemes, before later focussing on human resources development (Groenfeldt, 1989). A need to exchange experience amongst projects, and to monitor project investments **resulted in the development of a rapid assessment tool** designed to (1) select schemes for upgrading or rehabilitation; (2) evaluate ongoing rehabilitation work; and (3) facilitate long term monitoring. The rapid assessment instrument was developed that will take only half a day to undertake – insufficient time to provide details, but enough to generate useful information on trends and tendencies. The guidelines that were developed were found to have application for other IRDP stages including project pre-selection, feasibility/baseline studies and post-project monitoring. The tool should be used in a flexible manner, and adapted to the situation on the ground or stage of the project.

Community Managed Rehabilitation of Minor Irrigation Schemes (RMIS) Project, Sri Lanka

Also in Sri Lanka, the Department of Agrarian Development (DAD) and the United Nations World Food Programme (WFP) implemented the RMIS Project (ArcNews, 2004). A GIS-based inventory was developed that is able to (1) help with the selection tanks for future rehabilitation; (2) assess the impact of rehabilitated minor irrigation systems on poor farmer families; (3) monitor the sustainability of the rehabilitation process; and (4) measure changes in agricultural patterns and the process's impact on the living conditions of the poor farmer families.

Relevance for the ISI

As seen in a later section of this report, the Groenfeldt (1989) study will provide useful ideas for designing the ISI field data collection methodology. In the current initiative the careful selection of key variables will be important to ensure that field assessments are 'rapid'. GIS can be a useful real time tool for providing real time information of the status of irrigation schemes.

Expansion of irrigated agriculture

The following case study from Nepal describes how inventories can be used to determine opportunities for expansion of irrigated agriculture:

Farmer-managed irrigation systems (FMIS), Nepal

FMIS in Nepal make an important contribution to national food security; however this exact contribution is unknown because of limited accurate information on the extent of these irrigation schemes (Yoder, nd). This is partly due to the informal nature of many of these schemes which appear suddenly when water becomes available. There is also a great variability in the quality of management of schemes. This report documents the development on an inventory of schemes in one of the river basins representative of the hill areas of Nepal, the main purpose of which was to assess the number of schemes and irrigated area, together with the potential for expansion and intensification of irrigation schemes. The reconnais-

sance/inventory study identified 119 irrigation systems in the project area with canals longer than 0.5 km. These systems irrigate about 2,100 ha of land and were found to benefit approximately 10,100 households. In addition there are many systems with shorter canals and small command areas in the valley bottoms which have easy access to the available water. These were not included in the inventory because they have little potential for intensification or expansion. Some 21 of the 119 systems were identified as having potential for expansion. The study provides a combination of information on the agriculture system, management practices, and physical system, giving an insight into the constraints that must be overcome to make the systems more productive. If this type of study were to be carried out on a district-wide basis it would allow planners and policy makers to set priorities that would maximize returns on investment in development. Two limitations of the present study should be addressed in future work. The land area estimates need to be improved and potential areas where farmers have not been able to develop irrigation should also be examined.

Relevance for the ISI
Smallholder irrigation is considerably more regulated in Zimbabwe, than in Nepal where informal abstraction from the river network is the norm.

Determining implementation priority

The following case studies, both from Indonesia, describe how inventories were used to prioritise government owned schemes that could be handed over to communities:

An inventory to guide turning over irrigation schemes to farmers, Indonesia

Bayudono (1992) describes an inventory of FMISs that was established to facilitate the handover of small scale irrigation schemes of ≤500 ha, formerly managed by government of Indonesia, to Water Use Authorities. The inventory was used to evaluate the physical condition of the irrigation systems, institutional status of the authorities and performance level of the system either at the main and the tertiary levels, so that a detailed action plan could be prepared and implemented before handing over the irrigation system and its management responsibility to the authority. In order to do this a main objective was to provide detailed data and information on irrigation systems to be used as a database for evaluating system performance, preparing irrigation plans, designing rehabilitation or modification works, increasing water use efficiency and other planning activities.

An inventory to assess the impact of turnover of irrigation schemes to farmers, Indonesia

The impact of the turnover programme is assessed by Vermillion (1999) in terms of a number of impact indicators including costs of irrigation to the government and the farmers, quality of irrigation operations and maintenance, agricultural productivity, financial and economic viability of irrigation systems, and social implications of management turnover.

Relevance for the ISI
The study by Vermillion provides useful ideas on the assessment of financial and economic viability, important considerations for the sustainability of smallholder irrigation schemes in Zimbabwe.

Other examples of purposes of inventories

In addition to these categories, inventories have also been developed for other reasons. For example, the Government of Malawi (2012) created an inventory of small scale irrigation sites where Land and Water Management Agreements have been signed between members of WUAs and traditional land owners.

Inventory ownership and sustainability

Ownership

Priyanto (1992) highlights that the main reason for developing an inventory is to create a Management Information System (MIS) to make irrigation system development and management planning easier, more effective and more efficient. Stakeholders in Indonesia included three government ministries and their sub levels, credit unions, agricultural suppliers. They suggest that, for Indonesia, the Ministry of Agriculture is the appropriate organisation to act as the coordinator of information gathering and management. Then conveyance of data would be the responsibility of the agricultural agency at provincial level and the Ministry of Agriculture. Data would likely need to be updated annually to keep abreast of developments.

Since the local Indonesian WUAs were legislated to be responsible for running their irrigation systems, it was deemed that they should be responsible for carrying out the inventory programme for their own irrigation system (Bayudono, 1992). Local government implemented the programme with active involvement of the WUAs. This was seen as part of the normal duties of irrigation staff, negating the need to create a special operational unit or project to undertake the inventory. The primary end users of the inventory are (1) the government irrigation service and (2) the local Water Use Authorities.

In Tajikistan, the annually undertaken inventory is funded by the Minister of Land Reclamation and Water Resources (UNDP, 2013).

In Zimbabwe, the WISA inventory was undertaken by a team of consultants funded by the World Bank (WB, 2013). In their report it was recommended that future collection and management of the database should be done by relevant ministries with portfolios of water, agriculture, finance, health, mining, local government, etc. These stakeholders would add new projects to the database. Access to the database would be given to relevant ministries. Future use of database would (1) guide the Government of Zimbabwe and World Bank in the analysis of future investments in water sector and (2) provide data for the selection methodology required by the Project Selection Tool.

The rapid assessment tool (Groenfeldt, 1989) was jointly developed by the International Irrigation Management Institute and the Sri Lankan government's Regional Development Division. The two organisations had different requirements from the study – IIMI wanted methodology for assessing small irrigation schemes and having the methodology tested under field conditions; RDD wanted a methodology that would provide maximum information with minimal investment of staff resources on (1) scheme selection (2) level of beneficiary consultation and participation in rehabilitation (3) adoption of the recommended water programme and (4) economic benefits of the programme (e.g. increase in command area).

Relevance for the ISI

Databases are generally developed by the government, sometimes with the assistance of donors. In many cases, ownership of the database is not explicitly documented, the assumption being that ownership is with government.

Governments have the capacity to maintain such inventories which are unlikely to be profitable (see next section).

Sustainability

The sustainability of an inventory can be expressed in terms of financial or human resources.

Yoder (1992) notes that the returns on the investment in an irrigation inventory are indirect and not easily quantifiable.

World Bank note that there has been an exodus of skills and experienced people from all subsectors in Zimbabwe, and that restoring physical infrastructure is only one aspect – that sustainability requires building human capacity, not least in Operations and Maintenance (O&M).

Relevance for the ISI

There is little information available on database sustainability, perhaps because these are general government owned for development reasons with little thought of cost recovery.

Inventory processes and methodologies

In this section of the report we present the processes and methods used in (1) preparation for data collection; (2) field data collection and (3) post-collection activities.

Preparing for data collection

According to Lauraya et al. (1992), data collection methods include (1) Secondary documents; (2) Rapid Rural Appraisal; (3) Participatory Rural Appraisal (includes meetings); (4) Survey instruments and structured interviews; (5) Inventory checklists; (6) Sketch mapping; (7) Aerial mapping; (8) Satellite photography; (9) Geographical Information System (GIS) and (10) Walkthrough along the river from downstream to upstream. Some of these methods are confirmed by Vermillion (2000) who list (1) key informant interviews with farmers and irrigation agency staff; (2) walk-through inspections of irrigation networks; (3) farmer focus group discussions; (4) formal survey farmer questionnaires; and (5) secondary data kept by the Departments of Irrigation and Agriculture.

Examples of these methods are found in though out this section of the report.

Preliminary research and gathering of secondary information prior to field work

Vermillion (2000) describe how secondary data (where available and checked for reliability) can be used to compare intensities, yields, productivity and profitability of irrigated agriculture between turned-over and non-turned-over systems. In Tajikistan, the government started the inventory of irrigation systems by determining of the number of facilities and identifying the original cost of structures (UNDP, 2013). Pitana (1992) also mention secondary data collection for inventory data collection.

Development of the data collection instrument

Groenfeldt (1989) describes an open ended instrument for use in a rapid assessment, useful for the collection of qualitative information. Yoder (1992) provides important information on questionnaire design for the purpose of populating a database. The detailed questionnaire was drawn up using experience and information gained from prior research on farmer managed systems and was designed to solicit Yes/No responses rather than narrative descriptions to allow for ease of processing by computers. Questions were pre-coded to allow for the entry of field information on the form in a format that could be directly keyed into a computer database without recording.

Other examples of structured questionnaires include Bayudono (1992), who collected data through a field survey by means of standardized inventory instruments, such as questionnaire and inventory sheets; and Ibabao (1992) who describes how in the Philippines, the questionnaire for capturing inventory information was prepared by the planning and institutional development sections of the Regional Irrigation Office; before being presented for discussion to the inventory team which resulted in a few changes being made.

Pre-testing of the instrument

Ibabao (1992) describe how pre-testing of the inventory questionnaire was done at one irrigation scheme, allowing for further refining of the format and to determine the time required for an assessment (walk though and interview) as well as other practical considerations.

Groentfeldt (1989) describes how the Sri Lankan rapid assessment guidelines were tested in three climatic zones in one of the districts which resulted in the refining of objectives and field methods. A further field test, resulting in more changes, was done before passing the instruments on to the Plan Implementation Officer (PIO) responsible for this function. These officers benefited from an orientation training prior to using the guidelines in the field over a two month period, during which time they were adapted to personal use.

Development of a manual

Bayudono (1992) recommend the development of a manual of the inventory system that is important to explain terms, methodology, instruments, procedures, data processing and analysis, distribution of information.

Prearranging the visit

Ibabao (1992) started with the development of a schedule of field work. All irrigation schemes in each province were listed, and those in the same municipality scheduled for visits on the same day where time and distance allowed.

Groenfeldt (1989) describe how the PIO first makes a courtesy and information gathering visit to the district office. The local office will also arrange for the relevant field level government officers (cultivation and technical officers) to be available at the field. He recommends that district level officials are *not included* in the field visit – the composition of the assessment team is a trade off between knowledge of the scheme and objectivity. The aforementioned field officers (perhaps the equivalent of Agritex and Department of Irrigation officers) should be included; however their presence is likely to influence farmer's answers.

Relevance for the ISI

The procedures and methods outlined in the various reports and described above provide good ideas and information for the development of the ISI. Specifically:

- Development of data collection instruments – the most relevant insights are from Yoder (1992) who describes the development of instruments designed to feed data into a computing system, and which solicit Boolean and pre-coded responses.
- Pretesting of instruments – essential for determining the ease of information access and the enumeration staff competencies required
- Pre-arranging the visit – an inclusive approach will help ensure the cooperation and helpfulness of stakeholders. We learn from Groenveldt (1989) that it is sometimes necessary to *exclude* certain stakeholders from the field visit since their presence may influence farmer responses.

Data collection activities

The data collection team

In this section, we highlight the parties that were responsible for undertaking the inventory. There were four basic options –

- The users of the information. Groenfeldt (1992) describe how their rapid assessments tools were primarily used for collecting qualitative information by the *users of the information* – in this case, high ranking Plan Implementation Officers. They stress that rapid assessment are not suitable for collecting quantitative information – this sort of information should be collected by field level workers.
- Government workers. According to Bayudono (1992), their survey in Indonesia was done by a low ranking official of the Irrigation Service in conjunction with the WUA. The result was an inventory book of compiled raw data together with the Correction Sheet of verified data from the survey. The Box documents the structure of teams established for an inventory of capital assets in Tajikistan.
- Consultants. In Zimbabwe, the World Bank funded WISA was undertaken by constancy study team who liaised with a counterpart group of officials from key agencies during various workshops and meetings. The study worked under a steering committee chaired by the Ministry of Water with key agencies as members (WB, 2013).

Inventory teams for implementing a inventory of capital assets

In Tajikistan, permanently functioning inventory commissions were established for the inventory of capital assets (UNDP, 2013). The commission included a chairman, chief accountant, heads of structural departments (services), representatives of local administrations and representatives of public organizations (WUAs, *dehkan* farms, etc.). For inventory implementation, work groups were established in specific inventory zones which included a hydraulic engineer, an electrical engineer, an engineer of pumping stations, an accountant, a land Surveyor, an a representative of both the local administration and public organizations. A list of eligibility criteria was drawn up for work group members; for example, commission and inventory working group members should be approved by a head of the organization/owner of capital assets of irrigation systems. Also, personnel of the two groups should include experienced subject specialists who are well aware of the capital assets subject to inventory, their prices and primary records.

Relevance for the ISI

The data collection team – of the three options presented in the literature, there are two which could be considered in the Zimbabwean context. Use of suitably trained and capacitated national and local government officials (e.g. DOI, Agritex) in the team would be advantageous due to lower costs and local knowledge. A combination of government officials and consultants also has merits, particularly during an inception period.

The survey procedure

Visiting local structures and key informant interviews

Ibabao (1992) gave advance notice to the Irrigation Association (IA) and paid a courtesy call to the IA President or the next most senior IA officer. An introduction of the team was provided and a briefing of what was to be done. During the meeting a local guide was identified for the walkthrough and respondents for the institutional interview.

Vermmillion (2000) document how key informant interviews were primarily used to obtain qualitative and historical information about the turnover process and management context and about changes that were made in management practices as a result of turnover.

Field surveys

The farmer surveys provided information on farmer perceptions of performance before and after turnover, crop yields, and costs of irrigation (Vermmillion ,2000). Farmers were selected by random sampling, stratified by distance from the main water intake. Using layout maps, each system was divided into three blocks (head, middle and tail). Farm parcels in each block were given numbers and parcels were selected randomly within each block with the aid of a table of random numbers.

Walk-through inspections

Walk through inspections, in the company of informants, was common to most of the papers reviewed (e.g. Groentfelt, 1989; Yoder, nd; Vermmillion, 2000; Yoder, 1992; Ibabao, 1992; Pitana, 1992).

Vermmillion (2000) used the walk-through inspections to obtain data on the functional condition of the irrigation network and the cost of repairing damaged structures.

Groentfeldt (1989) provides considerable detail to the process of undertaking a walk-though for the purpose of a rapid assessment. Their basic model used in developing the guidelines was the inspection visit in which a senior national level government official (Assistant Director or Plan Implementation Officer) would spend few hours visiting a scheme where work was on-going – first looking at the head-works, then walking the channel whilst talking. The

assessment guidelines developed by Groenfeldt (1989) provided a more systematic framework for capturing these same types of observation. Key features of the rapid assessment guidelines included (1) discussion with farmers to get their points of view about the improvements; (2) inspection, in the company of farmers, of the physical system, form the head-works to the tail end fields; (3) Information from farmers about land tenure patterns; (4) information from farmers about water supply, allocation and distribution patterns; and (5) information from farmers and the cultivation officer on cropping patterns, supply of agro-inputs and marketing.

Before any information can be collected, there is a need to have informants present who can provide the necessary information. In the rapid assessment approach, there are three types of informants – (1) the lead farmer; (2) the construction committee and (3) regular farmers. It is recommended that the Plan Information Officer contact the cultivation officer ahead of time to organise informants – however again, it is essential to ensure objectivity since the responses of the (hand-picked) farmer group might be influenced by the officer. This can be mitigated by questioning other farmers (passers-by) during the survey.

The question of who does the survey is an important one – *the officer should not be linked to the scheme so as to maintain objectivity*.

Specific groups of questions are addressed to informants at certain locations at the scheme:

- Head works – this is where the visit usually begins. The interview includes categories of questions under a number of headings including general questions about the scheme, the planning, implementation and outcome of the rehabilitation work, recent history of the scheme, size of the command area in the past three to four years, number of households (owners/tenants), irrigated encroachers and household income patterns.

- Structures – O&M questions can be asked at the site of the structure/s in question (e.g. pump, main canal/pipeline, control valves). O&M questions are specific to the cropping programme, so rotations are also discussed. These questions evolve into questions on the organisation of the farmers. It is also recommended that questioning probes the farmer's understanding of the necessity/purpose for/of system components

- Fields – questions include those on water distribution, cropping patterns, agricultural practices, agro inputs and marketing.

Since the rapid assessment is designed for half a day, it is possible to complete two schemes, back-to-back, in one day. Such an approach is recommended by the author as it allows for comparisons to be drawn.

Yoder (nd) describes how the inventory team visited each irrigation system in the Nepalese basin. The most important activity was to walk along the length of the canal from the intake to the command area. One or a group of farmers was invited to accompany the team. While walking along the canal the farmers were questioned about the operation and maintenance of the system and the organization that was in place to carry out the various irrigation activi-

ties. Problems with the diversion and along the canal were discussed while making this inspection. Water in the source was estimated while inspecting the intake. Farmers were also asked to estimate the discharge in the stream and relate the observed discharge to that in each irrigation season. In addition to the consultant's estimate of discharge by visual inspection, he asked the farmers to make their own estimate by asking them how they measure water. Coupled with information from the farmers about the adequacy of the water supply for irrigating different crops and whether there was sufficient water to expand the area irrigated, the discharge information provided insight into the extent that the water resource had potential for further utilization. As far as possible, the command area was also inspected. This was a difficult task among the many ridges and valleys and not always possible in the time available. While examining the command area, farmers were also asked about their agricultural practices.

Yoder's (1992) method involved undertaking a single visit to the site, during which much walking was done – the interview team walked with farmers along the canal from the diversion through the command area in order to make a sketch en-route of the basic field layout.

Ibabao (1992) had two teams working simultaneously – the technical and institutional teams.

- The technical team undertook a system walk-though combined with a group interview. The walk-though was done with any irrigation farmers who were available. In most cases they were officers of the irrigators associations. For the technical inventory, the respondents were usually the IA water tender or IA President, or any other IA officer who had knowledge of the system's physical layout and characteristics. Then during the walk through, farmers they met were interviewed to further validate their observations and findings. The walkthrough was from either upstream or downstream, with the team making visual inspections of all irrigation structures (canals, pipes etc.) and recording all structures observed, their physical status and functionality, as well as marking them on a layout plan. In addition, discharge calibrations and soil analysis (upstream, midstream and downstream portions) were conducted during the walk through, as well as observations on visual geological analysis of the terrain.

- The institutional interview was done by a group interview and actual inspection of IA records and documents – with the consent and in the presence of the IA officer. Institutional inventory information was generally obtained from officials of the system's irrigators association such as IA President, Vice-President, Sectretary, Treasurer, Auditor and members of the Board of Directors who were knowledgeable of the organizational profile and systems management policies and practices of the association. Other members were tapped primarily for validation of data and observations.

Pitana (1992) describe how their inventory was started downstream and data gathered going upstream based on the assumption that farmers downstream generally had more knowledge about the upstream systems than the other way around.

Lessons learned

Ibabao (1992) list constraints and problems encountered, and action taken as (1) availability of farmers – farmers were only available at 9 of the 22 schemes that were visited, despite being pre-informed. This was found to be worst at non-operational systems; (2) the presence of Institutional Organizers during interviews of farmers was found to influence farmer responses especially when it was on issues related to them and management (e.g. conduct of meetings, record keeping); (3) factors related to poor weather and inaccessibility of the site and terrain – heavy rains affected five inventory visits resulting in one postponement; (d) time constraints - sometimes organisational challenges delayed the start of the inventories. On average, 88 and 79 minutes were required for the institutional review and technical walkthrough, respectively; and (e) Transportation challenges due to the non-availability of suitable vehicles.

Relevance for the ISI

- Visiting local structures – it is important that the research team visits district structures, prior to going to the scheme. Government departments at this level could also provide important information used to triangulate farmer testimonies.
- The question of who undertakes the survey, or Focus Group Discussion, is an important one – *the officer should not be linked to the scheme so as to maintain objectivity*.
- Walk-through inspections – this was the most common survey procedure identified and has merits when the scheme needs to be checked for technical viability. This also has merits when qualitative information is required. However, for an ISI which requires Boolean input the better tool is likely a Focus Group Discussion where multiple farmers gather and agree on responses to questions on their scheme. This is similar to the institutional interview described above by Ibabao (1992).

Post-visit activities

Debriefing

Groentfeldt (1989) describes how, after the field visit, the PIO stopped at the local district office to discuss observations with officers and problems raised by farmers. Details of what they expect to include in their report are also discussed.

Verification of data

In Indonesia, data obtained from the field for the inventory of FMISs was first verified with regards to validity and completeness (Bayudono, 1992). Doubtful data was checked against previous survey data, and resurveyed if deemed necessary. Verified new data was used to renew the previous inventory book(s). It was thought that ideally, the inventory should be updated annually or in accordance with irrigation activities in the field.

Output formats

Lauraya *et al*. (1992) report on eight options for output formats as required by primary users (farmers, agency, etc) including:

- Analytical reports. Analysis and synthesis, identification of priorities or subset of FMIS for potential intervention.
- Maps and schematics showing spatial relationships and key indicators.
- Narrative descriptions of each FMIS.
- Matrix. List of FMIS with columns showing indicator information e.g. in an inventory book.
- Diskette. Matrix information in e.g. Lotus 123 format.
- Database. Allowing easy search, ranking and selection of subsets of information.
- MIS database and procedures for updating and decision-oriented reports at different levels.
- Geographic Information Systems (GIS). Irrigation MIS and locations on digitized maps and links to other non-irrigation databases.

Examples of some of these output formats provided in the literature include:

- **Reports**: In the case of the Indonesian turnover scheme, collation of data/observations was done after the survey, between the technical and institutional teams, to then agree a common finalised report. In the case of non-operational systems, only a physical/technical inventory was undertaken and the inspection of these focussed around the dam and immediate vicinity.
- **Matrix**: In the Indonesian inventory described by Ibabao (1992) data was tabulated for storage. Pitana (1992) presented the results of the Bali inventory in matrixes of individual systems together with a description of a system along a river course.
- **Database**: Yoder (1992) recommends that a computerized database system be established to manage the field data. The software needs to be capable of analysing and reporting on the data as per the required output. Data capture in the field on a laptop would be helpful. There is a need to have full documentation for the end user, including an operation manual which can be used to train operators, data collectors. It is recognised that data collection – if it is to be useful – is hard work. It is costly to train teams, and data handling is a "mammoth task". Therefore if the database is not set up well, and updated regularly, it becomes useless and will not be used. The authors also note that tools like GPS will enhance the database, but require trained operators.

Priyanto (1992) recommend a multi-level, multi-agency gathering, storing, retrieving, processing and use of data, which then need to be integrated into the system. The structure of the database is not discussed in the report.

Relevance for the ISI

The ISI will be a computerised database and the paper by Yoder (1992) is particularly relevant:

- Data verification is important to ensure that the quality of information is maintained
- Regular updating of the information is key for maintaining the usefulness of the information
- Data collection and handling is expensive and requires significant resources

The discussions in this section of the report have thrown some light on the broad conceptual understanding of

- developing, organizing and conducting irrigation inventories
- developing and pre-testing data collection instruments;
- survey procedures; and
- up-dating inventories.

Helpful ideas were generated that improved the general understanding of conducting irrigation inventories. The general framework of the study as well as the trend of thinking was developed to some extent from the local and international experiences discussed in this chapter. These concepts were useful input in formulating the methodology of the study and building up from the general to the specific framework of the study.

Data fields which are important for inclusion in the inventory

The different inventories listed in the previous sections list many fields – many are common to more than one inventory whilst some are unique. Tables 1-5 are an attempt to categorise and list the fields that may be relevant for the investors wanting to use the ISI. The categories used are (1) material resources (water, land and infrastructure), and (2) human resources (scheme demographics and management, and agricultural productivity and marketing). References are provided for each field listed in the table.

In the previous section it was noted that fields for databases should be quantitative and avoid lengthy descriptions. Thus, in some cases, the tables have modified some of the questions so that they solicit responses that will result in alphanumeric, numeric or Boolean records.

Some practical advice for the ISI comes from Bayudono (1992) who warns against collecting too detailed information with broader range of data since it will require a large scale inventory activity that needs special efforts, skills, man hours, and an appropriate budget.

Material resources

Water

The source of the water is important to investors, as is information on the volume available compared to the actual and potential demand (Table 1). Also important is the reliability of the water source, and availability of records to illustrate this. The potential for expansion of the scheme, by more fully utilizing an existing resource is explored; taking cognisance that increased extraction may impinge on the water rights of others in the system. In order to understand the water balance, it is also necessary to understand the activities of encroached and illegal irrigators.

Table 1: Fields listed in the literature review on inventories – water resources

Field	Ref.
What are the primary and secondary sources of water? (e.g. spring, river)	3,8,9,11
What is the area of dam catchment, and its condition as regards soil erosion?	6
What is the stream discharge?	7
Are there records of stream flow?	5
What is the reliability of flow?	5
What volume of water is available?	7,8
Are there additional potential sources of water?	1
What is the average annual rainfall?	9
What is the water requirement of the scheme?	5
Is there sufficient water for existing cropping patterns and cropping intensity?	3,4,7
Is the existing source underutilized?	1

Can the existing source be expanded?	1
Can the spill level be raised?	8
How will this affect the downstream systems?	8
Are there competing non-irrigation water demands in the basin?	6
Are there water rights among systems diverting water from a given stream?	1
Is there potential conflict if more water is diverted from a particular system?	1
What are the water rights of current users?	1
Is there potential to bring in new users?	1
Is there any encroached irrigation?	8
What is the encroached water volume?	8
Is there any illicit irrigation?	8
What is the illicit volume?	8
Is there a scheme water balance available?	5

References cited: 1-Yoder (1992); 2-Ibabao (1992); 3-Pitana (1992); 4-Priyanto (1992); 5-Bayudono (1992); 6-Lauraya (1992); 7-Yoder (nd); 8-Groenfeldt (1989); 9-Vermillion (2000); 10-ArcNews (2004); 11-Gov Malawi (2012); 12-WB (2013a); 13-WB (2013b); 14-Aliev (2011).

Land

Table 2 lists fields that are included on land which include location of irrigated area, actual and potential command and irrigable areas; and distribution of land amongst plot holders. As is the case with water resources, some inventories are also interested in the presence and extent of encroached and illegal irrigators.

Table 2: Fields listed in the literature review on inventories – land resources

Field	**Ref.**
What is the location of the area covered?	3
What is the potential scheme command area?	8,9,11
What is the actual scheme irrigated area?	3,5,8,9
What is the average farm size?	8
What is the size of the three smallest farms?	8
What is the size of the three largest farms?	8
What percentage of the design area is being irrigated?	8
Is there potential to increase command area?	1,7
Is there potential to expand the irrigable area?	1,7
Is there any encroached cultivation?	8
What is the total encroached irrigated area?	8
Is there any illegal cultivation?	8
What is the total illegal irrigated area?	8

References cited: 1-Yoder (1992); 2-Ibabao (1992); 3-Pitana (1992); 4-Priyanto (1992); 5-Bayudono (1992); 6-Lauraya (1992); 7-Yoder (nd); 8-Groenfeldt (1989); 9-Vermillion (2000); 10-ArcNews (2004); 11-Gov Malawi (2012); 12-WB (2013a); 13-WB (2013b); 14-Aliev (2011).

Infrastructure

Fields on the scheme location and history are listed under infrastructure. Location details of some of the more dated literature included details of the administrative location; however a more recent inventory uses GPS coordinates and maps (ArcNews, 2003).

The most obvious infrastructural development at an irrigation scheme is the storage and water reticulation systems, and most inventories are interested in the existence and current condition of these structures. A list of all the possible assets included in the literature is not repeated in Table 3 for the sake of brevity. Suffice to say that most systems in the reviewed papers are gravity and canal fed and that system inventories often include fields such as length of main canal (km), total length of canal network (km) and area served/length of canal (ha/km) (e.g. Vermillion (2000).

Vermillion (2000) describes how the functionality of intake and full length of all main and distribution canals were classified. Such a classification might be useful for the ISI so it is dealt with in some detail here. Canal reaches and structures were classified as 'functional,' 'nearly dysfunctional,' and 'dysfunctional.' Canal lengths were considered 'defective' if one of the following problems existed and if it interfered with the desired hydraulic operation: (1) constriction or enlargement of the canal cross section (2) visible siltation and/or encroachment of freeboard or adjacent road (3) visible seepage (4) slippage, scouring, or other defects in the embankment (5) cracks or other damage to the canal lining.

A *functional* structure was defined as one that can currently perform its basic design function and shows no signs of losing this capacity within about a year. A *nearly dysfunctional s*tructure was one that was considered likely to become unable to perform its basic function within about a year. A *dysfunctional* structure was one that was unable to perform its basic function at the time of the inspection. For canal reaches, *dysfunctional* means it is unable to convey at least 70% of the desired flow capacity. *Nearly dysfunctional* means it is likely to become *dysfunctional* within about a year.

Control, conveyance, measurement, and ancillary structures were considered defective (i.e., dysfunctional or nearly dysfunctional) if one of the following conditions was present: (1) scouring of canal around structures (2) the approach section, rubble pack, or wings of structures are breaking apart (3) the water control structure cannot control flow as intended (due to gates or sills missing, eroded, or damaged, significant leakage at gates, or damaged mechanism of movable structures) (4) the water measurement structure cannot be used to measure flow due to a damaged or missing gauge, recorder, or other component (5) the civil works of ancillary structures are damaged or poorly constructed.

As part of the inspections, cost estimates were made for the repair of all dysfunctional and nearly dysfunctional canal sections and structures in the systems. Dysfunctional canal sections and structures were considered to be an "essential maintenance" cost. Nearly dysfunctional items were considered to be a "preventive maintenance" cost. The accumulation of

both was considered as the total deferred maintenance requirement. Such estimates might be useful for ISI investors.

Groenfeldt (1989) notes that although information on (rehabilitation of) physical works is available from project records, checking with farmers about the details of what were done is an effective way of eliciting their views.

A number of studies were also interested in the history of rehabilitation – who it was requested by, who undertook the work, costs of the work, when it was done – and so on.

Other types of infrastructure mentioned in the literature include roads, buildings and electricity infrastructure.

Table 3: Fields listed in the literature review on inventories – infrastructural resources

Field	Ref.
Name of scheme	8,11,12
Irrigation system type	9
Location of scheme	8,9,10,11,12
Date started	8,9
Date finished	8,9
Estimated cost	8
Actual expenditure	8
Location of the weirs?	3
What is the condition of the reservoir?	8
Is it silted?	8
What is the danger of continued reservoir?	8
Describe the type and condition of the irrigation structures or facilities to convey the water from source to farm.	3,4,5,6,7,8
What physical work is needed?	8
Details of previous improvements.	8
When were system repairs last effected?	8
What happened and how was it fixed?	8
When was the canal was last cleaned? Who helped and how was it arranged?	8
To what extent do physical system problems limit available water delivery?	1
Is there a road to the tank?	8
List of assets: Departmental roads, bridges (internal, and serving the scheme)	6, 14
List of assets: Buildings and their function	6, 14
List of assets: Power and telephone lines	14

References cited: 1-Yoder (1992); 2-Ibabao (1992); 3-Pitana (1992); 4-Priyanto (1992); 5-Bayudono (1992); 6-Lauraya (1992); 7-Yoder (nd); 8-Groenfeldt (1989); 9-Vermillion (2000); 10-ArcNews (2004); 11-Gov Malawi (2012); 12-WB (2013a); 13-WB (2013b); 14-Aliev (2011).

Human resources

Scheme demographics, structures and management

Table 4 lists the inventory fields based on scheme demographics and management. In some countries there are numerous WUAs along a single water course and details of these are of interest to investors – for example, coordination amongst the different associations.

Information about the irrigation community is obviously of key importance for an inventory and fields include past and current membership, the proportion of resident landowners, encroachers and illegal irrigators.

Farmer organisation is the key to the viability of a scheme. A glance at Table 4 reveals that there are many issues that communities of irrigators must deal with in order to keep the scheme operational and well maintained. The presence of a credible central farmer organisation, referred to in Table 4 as a Tank Committee or a WUA, is essential. A fairly large number of fields are used in the various studies which attempt to investigate issues around the energy, functions, authority, effectiveness and financial viability of the scheme committee/association.

Vermillion (2000) use the term *organizational viability* to refer to the capacity of the local organization to mobilize the support and resources necessary to continue to meet its long term objectives. The fields that most closely measure organizational viability are (1) farmer support for the organization (2) adequacy of fees paid by farmers to the organization (3) external legal recognition and (4) political acceptance of the organization.

Questions around the legal ownership of the scheme are also important, since they affect the ability of farmers to determine their own course and access loans.

Table 4: Fields listed in the literature review on inventories – Demographics and Management

Fields	**Ref.**
STREAM/SYSTEM MANAGEMENT	
What is the number of WUAs using the system?	3,6
Who are the existing WUAs?	5,9
What is the relationship/coordination of systems along a river course?	3
What is the present management status of the system?	3
IRRIGATORS AT THE SCHEME	
Number of irrigating families	3,5,8
Has this number changed since the completion of the scheme?	3,5,8
Number of irrigators (males and females)	11
What are the socio-economic characteristics of the farmers	4
What percentage of the land owners are resident?	8
What percentage of the farmers are tenants, and do they have land tenure?	6,8
What is the number of families in the encroached area?	8

Are encroacher's farmers or outsiders?	8
How has the encroached irrigation affected the regular farmers?	8
How many irrigators are illicitly tapping water?	8
What is the percentage of farmers with land outside the scheme?	8
FARMER ORGANISATION	
What are the farmer organisations at the scheme?	8
Who are the leaders of the WUA's?	3,8
How often are farmers meetings held?	6
Farmer perceptions of management constraints/problems.	6
Farmer suggestions/priorities for improvements.	6
When was the last water management meeting held? Who called it? Who came? What was decided? Have the decisions been implemented?	8
FUNCTIONS OF THE FARMER ORGANISATION	
What are the functions of the Tank committees?	8
Is there a constitution and bye laws available?	6,11
Does the WUA have authority to make rules and sanctions?	9
What is the maximum sanction available to WUA?	9
What has been the maximum sanction given since turnover?	9
Does the WUA have authority for the O&M plan and budget?	9
How did the tank committees participate in the decisions of the rehabilitation?	8
What is the operation and management of the system?	8
Are there written rules for water distribution/management?	8
How fairly is water shared amongst operators?	8,9
What is the adequacy of irrigation water supplied to the farms/plots?	9
What is the timeliness of water delivery to the farm?	9
Does the WUA have authority to hire or release staff?	9
Is there a systems operator? How active is he? Is he being paid? What has been the duration of service?	8
When was the most recent water dispute? How was it resolved?	8,9
What are the decisions of the Tank committees?	8
What is the efficiency of the WUA?	5
To what extent does lack of organisation limit the farmer's ability to improve the system on their own?	1
Is any fishing done in the tank?	8
Do farmers support the WUA?	9
LEGAL AND FINANCIAL VIABILITY	
Who is the legal owner of the scheme?	4,9
Is the WUA a legal entity?	9
Does the WUA have a right to contract and raise funds?	9
Is there legal water right at level of system or farmer organization?	9
Does the WUA have authority to set water fees?	9
Is there a record of fees collected?	9
What is the adequacy of fees paid by farmers to the organization?	9
What is the financial status of the WUA?	5
Does the WUA have a right to make profits?	9
Have farmers invested in improvements?	9
Is there external legal recognition and political acceptance of the organization?	9
Does the WUA have control over intake, main canal system and subsidiary canal system?	9
Who has the responsibility for future rehabilitation?	9
Details of contact person at the scheme	8

References cited: 1-Yoder (1992); 2-Ibabao (1992); 3-Pitana (1992); 4-Priyanto (1992); 5-Bayudono (1992); 6-Lauraya (1992); 7-Yoder (nd); 8-Groenfeldt (1989); 9-Vermillion (2000); 10-ArcNews (2004); 11-Gov Malawi

(2012); 12-WB (2013a); 13-WB (2013b); 14-Aliev (2011).

Agricultural productivity and marketing

The final table of inventory fields deals with agricultural productivity and marketing. Cropping patterns and intensity and productivity are important, as is water use management and irrigation efficiency. The market orientation of farmers, crops marketed, popular market places are also found in a number of studies. Production often needs to be coordinated which can be done through cultivation meetings (Groenfeldt, 1989). Finally, the existence and quality of government extension (and other) services is mentioned in a number of studies.

Table 5: Fields listed in the literature review on inventories – agricultural productivity and marketing

Fields	Ref.
What are the gender roles in agriculture and irrigation?	6
Is there adequate labour available for cropping?	6
What is the predominant soil type?	9
Are there daily records of rainfall?	6
Are there records for daily, monthly evapotranspiration?	6
Is there a problem with drainage and where?	6
What drainage structures are in place?	6
What is the (main) cropping pattern for wet season and dry season?	5,6,9
What is the cropping intensity	5
Are there different crops grown in different parts of the irrigation scheme?	8
What are the levels of production? Yields? Other related variables?	5,8
Is there potential for increasing the cropping intensity?	1
Give reasons why farmers were not cultivating the full area?	8
What are the farmer agricultural practices? e.g. land prep., planting, cultivation?	6,7
What is the degree of subsistence/market orientation of the existing irrigation users?	1
To what extent might crop selection be used to manage a scarce water resource?	1
What is the agricultural technology and water use management?	4
What is the level of irrigation efficiency?	5
When was last cultivation meeting? Who participated? Were decisions implemented?	8
What government services doe farmers at the site have access to?	8
Who are the other government officers assigned to the scheme? How active are they? Good/fair/poor	8
What agricultural production support facilities are available?	4
Where do farmers get their agricultural inputs from?	6
Are there issues with loan dependency?	6
How profitable is crop production?	6
How active is the cultivation officer? Good/fair/poor	8
Which crops are marketed?	8
What is the percentage crop marketed?	8

Are the farmers market-oriented?	8
Where are the farmer markets? Farm gate/local town/city/main city	7,8
What transport do farmers use to get produce to market?	6
What percentage of families purchase the staple crop?	8
Do the farmers take bank loans	8
Are the farmers in debt? To Whom?	8
Are farmers engaged in any other employment?	8

References cited: 1-Yoder (1992); 2-Ibabao (1992); 3-Pitana (1992); 4-Priyanto (1992); 5-Bayudono (1992); 6-Lauraya (1992); 7-Yoder (nd); 8-Groenfeldt (1989); 9-Vermillion (2000); 10-ArcNews (2004); 11-Gov Malawi (2012); 12-WB (2013a); 13-WB (2013b); 14-Aliev (2011).

Relevance for the ISI

This section of the report has provided a useful categorisation of fields that can be used to populate the ISI. Within each category there are comprehensive lists of fields that have been used in other inventories. This information provides an excellent structure and resource for the next part of this ISI study when local stakeholders (including potential investors) will be asked to describe the type information that they would like to have access to in a database to guide investment decisions.

Local stakeholders and their perspectives on the need for an irrigation inventory

Most of the inventories mentioned in this review were established for government and other investors for the assessment of irrigation schemes. Information focused on

- Scheme functionality and the requirements for getting them fully operational (e.g. Yoder; 1992; Ibabao, 1992; Pitana, 1992 etc.).
- Softer issues on scheme management to determine the capacity development requirements of farmers.

In drafting a Policy Framework on Agricultural Water Management, Madyiwa (2007) has proposed a number of policy statements to be addressed by the Government of Zimbabwe (GOZ) including the lack of data base on irrigation schemes. The proposal urges the GOZ to carry out an inventory and audit of all irrigation schemes in the country with a view to determining the areas irrigated, technologies being used, state of irrigation infrastructure and major crops grown on the schemes. Government would use the database to determine new categories of irrigation schemes, their needs including rehabilitation requirement and mobilize resources for sustainable irrigation development and management.

Relevance for the ISI

The ISI programme partially conforms to the needs of the Government of Zimbabwe, as identified in the literature under review. With its focus on investment opportunities, the ISI will not necessarily capture detailed information required by government – for example, on the state of irrigation infrastructure.

Data about irrigation schemes that is currently available in the literature

The purpose of this section of the report is simply to provide an inventory of reports on irrigation schemes in Zimbabwe (Table 6). This could provide secondary information to populate some of the database fields.

This literature review precedes the stakeholder interviews which will also be used to identify additional literature to add to the list. For example, it has been reported that the Department of Irrigation have a list of existing irrigation schemes and their status as part of an irrigation master plan. This will assist in further development of the Table. Other organisations which have done considerable work with irrigation schemes, and which should be resource-rich include EU, FAO and Zim-AIED.

Table 6: Inventory of reports of irrigation schemes in Zimbabwe

Scheme	District	Ref	Physical Resources			Human Resources	
			WR[1]	LR[2]	IS[3]	D&M[4]	P/M[5]
Manicaland Province							
Mupangwa	Mutasa	Zim-AIED (2011)	✓	✓	✓	✓	✓
Mupangwa	Mutasa	Dawes (2006)	✓	✓	✓	✓	✓
Mutarazi	Mutasa	Zim-AIED (2011)	✓	✓	✓	✓	✓
Makuwaza	Mutasa	Zim-AIED (2011)	✓	✓	✓	✓	✓
Manunure	Mutasa	Zim-AIED (2011)	✓	✓	✓	✓	✓
Honde Mupotedzi	Mutasa	Zim-AIED (2011)	✓	✓	✓	✓	✓
Mutsamba Butsi	Mutasa	Zim-AIED (2011)	✓	✓	✓	✓	✓
Ngwinyai Muparutsa	Mutasa	Zim-AIED (2011)	✓	✓	✓	✓	✓
Chitora	Mutasa	Zim-AIED (2011)	✓	✓	✓	✓	✓
Samanga Dumba	Mutasa	Zim-AIED (2011)	✓	✓	✓	✓	✓
Masara Heights	Mutasa	Zim-AIED (2011)	✓	✓	✓	✓	✓
Ngarura Mupinda A	Mutasa	Zim-AIED (2011)	✓	✓	✓	✓	✓
Mupenga	Mutasa	Zim-AIED (2011)	✓	✓	✓	✓	✓
Chipendeke	Mutare	Dawes (2006)	✓	✓	✓	✓	✓
Masvingo Province							
Rozva	Bikita	SDC (2010)	✓	✓	✓	✓	✓
Rozva	Bikita	FAO (2000)	✓	✓	✓	✓	✓
Makonese	Chvi	GOZ (2004)	✓	✓	✓	✓	✓
Stanmore	Masvingo	Dawes (2006)	✓	✓	✓	✓	✓
Rupike	Masvingo	SDC (2010)	✓	✓	✓	✓	✓
Magudu	Masvingo	GOZ (2004)	✓	✓	✓	✓	✓
Mapanzure	Masvingo	SDC (2010)	✓	✓	✓	✓	✓
Oatlands	Masvingo	FAO (2000)	✓	✓	✓	✓	✓
Longdale	Masvingo	FAO (2000)	✓	✓	✓	✓	✓
Pfuve Panganayi	Zaka	SDC (2010)	✓	✓	✓	✓	✓
Mashonaland East Province							
Wenimbi	Marondera	FAO (2000)	✓	✓	✓	✓	✓
Chitora	Mutoko	FAO (2000)	✓	✓	✓	✓	✓
Murara	Mutoko	FAO (2000)	✓	✓	✓	✓	✓
Mawire East	Wedza	Dawes (2006)	✓	✓	✓	✓	✓

Mashonaland Central Province							
Principe	Shamva	FAO (2000)	✓	✓	✓	✓	✓
Johannadale 2b	Chegutu	Dawes (2006)	✓	✓	✓	✓	✓
Matabeleland South							
Mzinyathini	Umzingwane	FAO (2000)	✓	✓	✓	✓	✓
Midlands							
Hama Mvhaire	Chirimanzu	Dawes (2006)	✓	✓	✓	✓	✓
Ngezi Mamina	Kadoma	FAO (2000)	✓	✓	✓	✓	✓
Mambanjeni	Gweru	FAO (2000)	✓	✓	✓	✓	✓

Notes: 1. Water Resources; 2. Land Resources; 3. Infrastructural Resources; 4. Demographics and Scheme Management; 5 Agricultural production and markets

There are also a number of existing lists of irrigation schemes in Zimbabwe which include some of the details:

Unknown source (to be identified during the Stakeholder interviews) lists scheme name, location (province, district, sometimes ward and map reference), area under irrigation, potential command area, number of beneficiaries, water source, water supply system and irrigation system type.

Zim-AIED (2012) lists scheme name, location (province and district), area under irrigation, number of beneficiaries and management responsibility.

Relevance for the ISI

The secondary information provided in this section will perhaps not be very relevant since much of it is outdated. Information that does not change at all (e.g. scheme type, water source, location etc.), or that changes infrequently (e.g. scheme area, number of irrigators etc.) will likely be more easily available from the DOI headquarters.

Data collection methods used for inventories identified in the Zimbabwean literature

This final section of the report focuses on methods used in studies to access data.

Recent and past investments in the smallholder irrigation sector

In Zimbabwe, records on the Public Sector Investment Programme (PSIP) from the relevant government institutions namely, Department of Irrigation and ZINWA, responsible for smallholder irrigation development programmes are an important source of information. For example, GOZ (2013e) received a list of irrigation schemes from DOI that prioritised those for financing in the 2013 GOZ budget (including estimated investment costs). Other sources of this information include records from NGO's and records from Development Partners obtained from their web sites.[3]

Data collection at the irrigation scheme level

Table 7 lists the categories of data that are included in the Terms of Reference for this study. The studies reviewed in this report have accessed this information from numerous sources.

Unpublished records, available at national, provincial and district offices of relevant government institutions (e.g. Agritex, DOI, ZINWA) have provided useful information on technical knowhow of farmers (e.g. SDC 2010 and 2012), current state of irrigation systems (e.g. Madyiwa, 2013; DOI, 2013) and current production trends and outputs (e.g. SDC 2010).

Stakeholders at the scheme and within the community including the Irrigation Management Committee (IMC), Agritex Extension Officer, individual farmers or groups, and traditional leaders; have provided information on all of the listed categories in various studies (JICA, 2003; IWMI, 2012; and Makadho, 2012).

In Zimbabwe there is no rigorous protocol required for obtaining or reviewing documents at the provincial and district offices of the relevant government departments. Information on irrigation schemes is not classified. The basic requirement for accessing this data is identification details, the nature of work and intended use of the information.

Table 7: Data sources used by developers of other Zimbabwean irrigation inventories

	Source of information								
	ATX[1]	DOI[2]	ZINWA[3]	IMC[4]	IM[5]	EO[6]	F[7]	PR[8]	TL[9]
Technical knowhow of	✓	✓			✓	✓	✓		

[3] For example, http://eeas.europa.eu/delegations/zimbabwe/index_en.htm/ gives information on EU support to Zimbabwe's Agricultural sector including project name and objectives, estimated investment and location. The latter are accessed either directly or through the relevant government departments that will have received funding.

farmers									
Current state of irrigation systems	✓		✓						
Current production trends and outputs	✓	✓		✓	✓	✓	✓		
Socio-economic situation of farmers					✓	✓	✓	✓	
Scheme history							✓	✓	
Scheme management and governance				✓	✓				✓
Access to input and output markets				✓	✓		✓		

Notes. [1] Agritex [2] Department of Irrigation [3] ZINWA [4] Irrigation Management Committee [5] Irrigation Manager [6] Irrigation Extension officer at the scheme [7] Farmer Key Informant Interviews [8] Published studies [9] Traditional leaders

Relevance for the ISI

The ISI will develop a robust methodology for obtaining information from the different sources listed in this section. Triangulation of data will ensure that the information accessed from the database will be accurate.

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