Lessons Learned on Grain Quality Control & Mobile Information Systems within Zambia's Food Reserve Agency

FOOD RESERVE AGENCY

UNIVERSITY of GREENWICH | Natural Resources Institute

WFP World Food Programme wfp.org

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Contents

Acronyms

CAP:	Cover and Plinth temporary storage
EFSRA:	Emergency Food Security Reserve Administration
FAO:	United Nations Food and Agriculture Organisation
FIFO:	First In, First Out
FISP:	Farmer Input Support Programme
FRA:	Food Reserve Agency
GIN:	Goods Issued Note
GRN:	Goods Received Note
ICT:	Information and Communication Technology
IDT:	Inter-Depot Transfer Note
IPT:	Inter-Provincial Transfer Note
ISP:	Internet Service Provider
M&E:	Monitoring & Evaluation
MIS:	Management Information System
M-Tech:	Mobile Technology
NEPAD:	New Partnership for Africa's Development
NRI:	Natural Resources Institute
PPP:	Public-Private Partnerships
SCPs:	Satellite Collection Points
SGR:	Strategic Grain Reserve
SIM:	Subscriber Identity Module
SMS:	Short Message Service
SSA:	Sub-Saharan Africa
WFP:	United Nations World Food Programme

Foreword

The Food Reserve Agency's (FRA) core functions are to efficiently manage sustainable National Strategic Food Reserves, ensuring National Food Security and Rural Income through the provision of complementary and high quality marketing and storage services, in line with international standards. In order to achieve this, the systems, processes and procedures must be aligned to the objectives of managing the strategic food reserve.

In July 2013, the FRA and the World Food Programme (WFP) signed a Technical Agreement to undertake a Pilot Project in Katete district in the Eastern province of Zambia. The objective of the pilot project was to test improved methods and new technology to strengthen systems and procedures in order to minimize losses and increase efficiency. This was to be achieved through monitoring grain quality at both satellite and main depots, and through creating a mobile data collection system that tracks the commodity and transportation along the supply chain.

The results obtained from the pilot show that implementing enhanced grain quality interventions at both satellite and main depot levels is possible and effective. In addition, the pilot showed that implementing an effective mobile technology would result in the generation of good quality data which can be used in real-time. This facilitates effective management of grain quality, quantity, transportation and storage.

The FRA is hopeful that the collaboration with WFP will be on long-term basis in our mutual efforts to deal with the aspects of improving the final grain quality available in the National Strategic Food Reserve.

On behalf of FRA management, I wish to sincerely thank and commend WFP for initiating this progressive gesture of conducting a pilot project on very important components of our programme namely, crop quality, data management and commodity tracking.

Chola Kafwabulula

Executive Director
Food Reserve Agency (FRA)

Executive Summary

An important function of a national strategic food reserve is to ensure that food is stored safely and that its quality is guaranteed. In order to achieve this function efficiently the systems, processes and procedures of the organisation must be aligned to the objectives of managing the strategic food reserve. The Food Reserve Agency (FRA) and World Food Programme (WFP) agreed to test innovative procedures aimed at improving the quality of the maize in the FRA's supply chain and ensuring the capture and real-time transmission of key data from the Satellite Collection Points (SCPs) to the District Main Depot. This report outlines the activities undertaken and the lessons learned during this pilot project.

The Pilot Project activities were divided into five components:

1. Training of FRA staff in grading and visual assessment of grain
2. Training of fumigation contractors and FRA staff in fumigation procedures and checks
3. Set up of District Depots with necessary equipment
4. Operational processes and procedures at District Depots
5. Gathering data and the establishment of Management Information System (MIS), through the use of Android tablets/Mobile Technology (M-Tech) to enable communication between SCPs and the District Main Depot, and enhanced monitoring and evaluation of the pilot project.

The Quality component of the pilot resulted in improved maize quality at Strategic Grain Reserve (SGR) intake point (99.6 percent Grade "A") and the protection of stocks through proper fumigation. The M-Tech component of the pilot proved the concept that the use of mobile technology can improve real-time data collection and usage within FRA operations, resulting in 100 percent accountability of stocks, improved tracking of transport movements and a database of purchases that will allow analysis of data for a variety of purposes. In addition to the qualitative learning discussed in this report, other benefits include the deployment of an improved set of risk mitigation measures. The investment for the project is recovered through the results obtained.

However the pilot also made it clear that the implementation of solutions for grain quality management and information management cannot be looked at in isolation, as such solutions are influenced by several external factors which affect the operational modalities of FRA. These include, but are not limited to, the business model which dictates an extensive depot network, the inadequate storage infrastructure; as well as internal factors such as the manual stock management information system and motivational issues associated with employing seasonal staff.

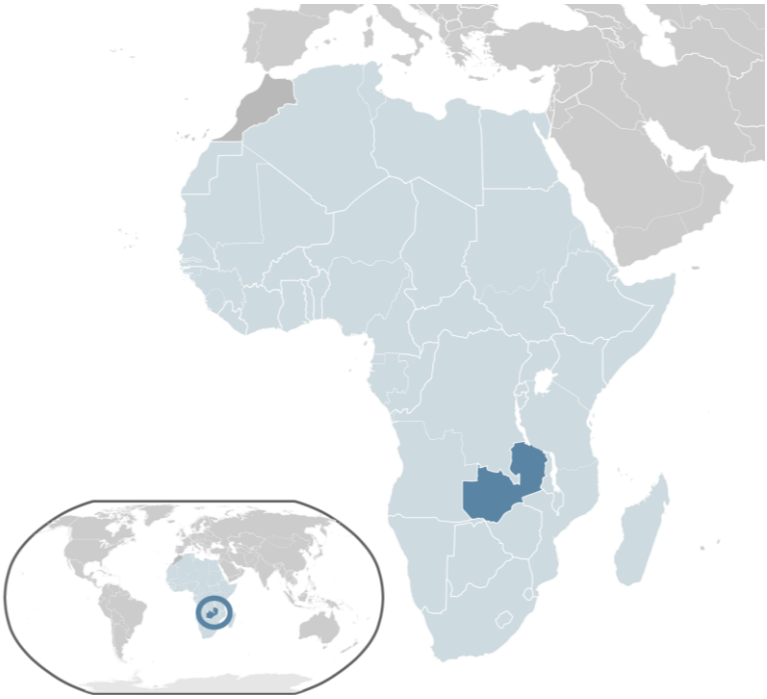
The Pilot has shown that solutions similar to those tested will have a positive impact on the FRA's operational efficiency. Scaled-up solutions, adapted through up-scaled design specifications, will be able to deliver and are worth their investment. These solutions will need to remain scalable, bearing in mind the need for investment in the other factors that influence their successful implementation.

1 Introduction

1.1 Background

The Republic of Zambia is a landlocked country in Southern Africa, neighbouring the Democratic Republic of the Congo to the north, Tanzania to the north-east, Malawi to the east, Mozambique, Zimbabwe, Botswana and Namibia to the south, and Angola to the west.

Figure 1: Zambia, location (source: Wikipedia)

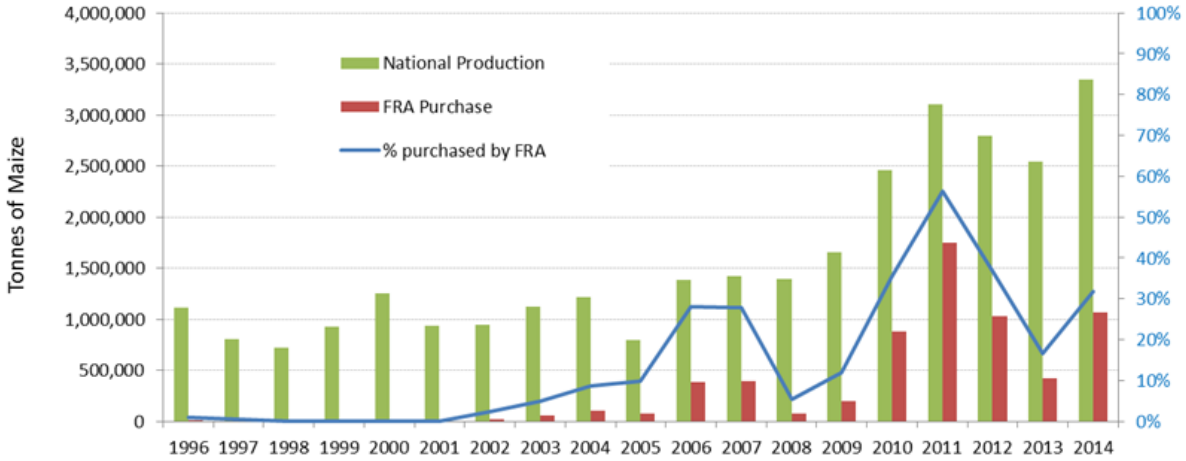


Maize in Zambia is both the national staple food and the most commonly grown crop by smallholders, defined in Zambia as a farm household cultivating up to 20 hectares of land. As a result, it is the primary focus of public expenditure on agriculture in the country.

In recent years, the number of smallholders growing maize has increased in Zambia, reaching 86 percent of the 1.2 million smallholders in the country in 2011/12, with the highest incidence of maize production in the Eastern Province. This translates into over 1.2 million hectares of smallholder land dedicated to maize production, representing approximately 66 percent of the total smallholder land under cultivation in Zambia.

The FRA was established as a strategic national reserve by Act of Parliament in 1995. At the time it was charged with holding grain reserve stocks of 150,000 metric tons (mt); some of which would be used as funds for future contracts. This reserve stock was gradually increased over the years to around 600,000 mt. In 2005, an amendment to the act was passed to enable the FRA to function as an agricultural marketing board that intervenes in the market by buying grain directly from farmers at collection points situated near the production areas, herein referred to as satellite collection points (SCPs). This grain is moved to main holding depots and released on national markets (preferentially to millers) and export markets. In recent years, annual procurement has often been in excess of 1,000,000 mt housed in permanent stores of some 750,000 mt capacity and the remainder in temporary cover and plinth (CAP) storage. This very large procurement has been achieved by a massive increase in the number of SCPs, which previously numbered about five per district but in recent years have numbered about fifteen, resulting in over 1,000 SCPs across Zambia, many in relatively inaccessible locations.

Figure 2: National Production of Maize and FRA Purchases (1996-2014)



The large levels of procurement resulting from the FRA's new role were associated with grain quality problems and postharvest losses in 2010 and 2011. These were due to a combination of long periods of temporary storage, inadequately maintained permanent storage and to the poor control of quality at grain procurement (FAO, 2012).[1] The current procedure is for FRA to procure maize from farmers at only Grade A of the Zambian standard. This grade is not enforced rigorously and, after procurement, at times of movement between storage sites, grain quality is not checked.

To support FRA to procure better quality grain from farmers and to assure grain quality within its system, the UN World Food Programme offered to review grain quality management procedures at SCP and main holding depot, and to consider specifications for a Quality Assurance Unit. This led to a 9-day review in January/February 2013 undertaken by staff of the Natural Resources Institute (NRI) and WFP, in association with FRA. Subsequently, a pilot project to test and demonstrate an approach to quality management was designed and run in Katete district, Eastern province during the 2013 marketing season. The lessons learned from this pilot, with fine tuning, could be applied throughout Zambia.

[1] Kalinda T, Stubbs I., Van de Ven (2012) Brief assessment of the agricultural market and trade environment in Zambia – an indicative action plan for agricultural market reform. UN Food and Agriculture Organisation, Rome, Italy. Typewritten, pp. 21.

1.2 The Pilot Project

1.2.1 Grain Quality Component

The Plan

Pilot project on grain quality management with FRA in Katete in collaboration between FRA, WFP and NRI.

The design of the pilot followed two mission reports, the first on grain quality issues at the Zambian Food Reserve Agency (FRA),[2] and the second developing a plan for this pilot project to strengthen grain quality management.[3] The pilot was implemented in the 2013 maize procurement season within one district in the Eastern Province, Katete.

The two previous missions prepared a global plan for improvement of the operations of FRA in the district, with interventions at the level of:

- Farmers (sensitisation),
- Satellite Depots – hereafter referred to as Satellite Collection Points or SCPs[4] (training of FRA operatives, improved equipment, and reinforced processes and procedures),
- District Depot (training of FRA operatives, improved equipment, and reinforced processes and procedures) and,
- Communications between SCPs and District Depot, in collaboration with WFP's M-tech project in the sub-provincial marketing

A strong Monitoring and Evaluation component was planned to work alongside these project activities, allowing both project management in real time and the preparation of an advisory report on completion of the pilot, for FRA strategic planning.

The Reality

The start of the 2013 marketing season was announced just after the crop estimate was made public. At that time, the FRA crop marketing modalities for this marketing season were not yet finalised, with the Ministry of Agriculture and Livestock announcing the possibility of a bartering system in conjunction with Farmer Input Support Programme (FISP).

It was therefore decided to reduce the scale of the pilot and concentrate mostly at the District Depot level, and on the SCP-District Depot communications element. Information captured mostly at District Depot was used to assess those points in the value chain that have a major impact on grain quality. Consequently, any need for work at the level of SCP or with the farmers would become the subject of subsequent recommendations.

[2] Hodges R.J. and Tran B.M.D. (2013) Grain quality control for the Zambian Food Reserve Agency: strengthening the system and a proposal for a pilot project to test quality management options. Typewritten, pp 22.

[3] Tran B.M.D., Forsythe L. and Hodges R.J. (2013) Pilot Proposal: Grain quality control for the Zambian Food Reserve Agency. Typewritten pp 53.

[4] FRA's **Satellite Depots** are renamed **Satellite Collection Points** (or **SCP**s) in this report to highlight the crucial point that maize should not be stored there and describe their main function of maize aggregation. Accordingly, **District Main depots** are renamed **District Depots** to highlight the point that this is where maize is stored at the district level.

1.2.1.1 Pilot Project Objective

To test improved methods and new technology to strengthen systems and procedures in order to minimise associated and generic postharvest losses and increase efficiency:

- Through monitoring grain quality at the Satellite Collection Points (SCP) and the District Main Depot by setting up a grading lab in Katete
- Through creating a mobile data collection system that tracks the commodity and transportation along the supply chain (from the SCP to the Main Depot) in real time.
- Through lessons learned from the pilot project develop a strategy for scaling up.

The Technical Agreement between FRA and WFP was signed in July 2013, and the pilot project commenced during the same month.

In the process, valuable information on the functioning of Satellite Collection Points and the transport of commodity between those and the District Depot would be collected.

The main output of the project is this report to be presented to FRA, with specific and informed suggestions for improvement of their operations at the national level.

1.2.1.2 Pilot Project Activities

The Project activities were divided into 5 components:

1. Training of FRA staff in grading and visual assessment of grain
2. Training of fumigation contractors and FRA staff in fumigation procedures and checks
3. District Depot set-up and equipment
4. Operational processes and procedures at District Depot
5. Management Information System (MIS), including use of Mobile Technology (M-tech) solutions for correspondence between SCP and District Depot and monitoring and evaluation of the project

1.2.1.3 Project deliverables

Timeframe and milestones had to be very flexible and aggressive, given the very short marketing season and the relatively late start of the pilot activities. The deliverables were to be:

- Monitoring reports on:
  - the processes at SCP level and at district depot level,
  - the quantity and quality of the grain purchased,
  - the grain quality changes observed during storage,
  - the transport of grain between SCPs and the district depot,
  - the communication channels between SCPs and depot, and with the sub-province, including the m-tech pilot in Katete,
  - the quality of fumigations.
- Evaluation report, lessons learned report and strategic recommendations for up-scaling
- Proposal for future strategy

1.2.2 The Mobile Technology (M-Tech) Component

The mobile technology (or M-tech) component of the pilot project was done in collaboration with FRA, WFP and Summum, a Zambian ICT consultancy.

1.2.2.1 Pilot Objectives

The specific objective for the mobile technology component was to setup a management information system at the district depot that links and collects the data, through a mobile data collection platform, from the SCPs. The MIS system was designed to be able to track the flow of maize in and out of the SCPs in order to strengthen grain quality assurance, stock transport, farmer payments, purchase data etc. The system aimed at showing a true picture of the distribution, size and grades of stock held without significant delays, and was used to trigger timely transport from the SCPs, purchase data and also pest management action at Depots.

1.2.2.2 Pilot Activities

The Project activities for the mobile technology component were:

Phase 1. Design, programming and testing of the system
Phase 2. Implementation of the system in Katete and training of the users
Phase 3. Ongoing support, monitoring and evaluation of the system

1.2.2.3 Pilot Deliverables

The project deliverables for the mobile technology component were:

For phase 1:

- Final version of the system
- Detailed pilot phase design

For phase 2:

- Full working, tested and implemented system in Katete
- Training of all the staff

For phase 3:

- Design of the M&E framework
- Continuing support to the FRA for the system
- Monitoring and evaluation report

1.3 Benefits

In addition to the qualitative learning discussed in this report, the benefits of this pilot can be highlighted in the following terms:

Losses are significant throughout the supply chain and particularly during storage and transport (see www.aphlis.net for estimates) and hence an investment in loss reduction such as demonstrated by the pilot pays off.

The reduction in losses of maize as a consequence of both the Quality and M-Tech components has been documented. Improved maize quality was achieved at SGR intake point (99.6 percent Grade "A"), which by international standards is an excellent achievement, and through enhanced management of the fumigation process. The use of mobile technology resulted in 100 percent accountability of stocks thereby eliminating the potential losses of maize normally incurred during transportation.

The project was presented to local authorities in Katete district, who were then updated about progress and results. The District Commissioner and the District Agricultural Coordinator were interviewed by project staff on completion of the pilot and expressed their enthusiastic support. Their feedback is reported in appendix 1.

2 The Pilot Project

2.1 Grain Quality

2.1.1 Sampling and Grading

2.1.1.1 Recruitment and training

During August and September 2013, the following activities took place in relation to recruitment and training:

- Four new FRA staff were recruited to be allocated to the pilot. As trucks were filling up the yard, FRA was requested to authorise the hiring of the 4 staff on daily basis until their contract was ready.
- The four graders were trained in sampling methodology and started practicing on the day.
- The four graders started their sampling duties: the first truck was sampled by all graders under NRI's supervision, and then the graders were divided in two groups and sampled trucks in pairs for the rest of the day. The team was able to sample 12 trucks, carrying from 250 to 650 bags, on their first day.
- New sampling spears[5] were issued to the graders.
- The graders were trained on grading and started grading the samples.
- Three additional graders were recruited, one was reallocated to the District Depot as a clerk.
- After confirming their practice skills, a written test and an individual interview, the graders were presented with a certificate.

2.1.1.2 Activities

Random samples were taken from over 500 trucks bringing maize from the SCPs between the 27th of July and the end of September and subsequently graded and stored in a secure container provided by WFP.

[5] Sampling spears are colloquially referred to as "Probing Sticks" by FRA staff.

Figure 3: Sampling During Offloading at FRA Depot in Katete

The samples were then graded in the new Katete grading lab, by the trained FRA staff.

Figure 4: Grading of Samples at FRA Depot in Katete

The Zambian Standard, as available from the Zambian Bureau of Standards, defines 3 grades (A, B and C). The table below shows how the Zambian standard defines maximum levels of defective grains and moisture content for the 3 grades:

Table 1: Maximum Levels of Defective Grains and Moisture Content from the Zambian Standard[6]

	Specification		
	A	B	C
Moisture content (max. %)	12.5	12.5	-
Defective grain			
Diseased grain (max. %)	2.0	2.0	2.0
Shrivelled grain (max. %)	0.1	0.5	1.0
Insect damaged grain (max. %)	3.0	5.0	10.0
Discoloured grain (max. %)	4.0	6.0	10.0
Other coloured grain (max. %)	2.0	3.0	4.0
Broken grain (max. %)	2.0	3.0	4.0
Foreign matter (max. %)	1.0	1.5	2.0
Total defects (max. %)	14.1	21.0	33.0

As the FRA's requirements have been to only purchase grade A, for this pilot project in Katete, the following three grades were defined: A1 and A2, corresponding to very good quality and acceptable quality respectively, and grade B, which technically should be rejected.

Table 2: Standards Applied within the Katete Pilot

	Specification		
	A1	A2	B
Moisture content (max. %)	12.5	12.5	12.5
Defective grain			
Diseased grain (max. %)	2.0	2.0	2.0
Shrivelled grain (max. %)	≤0.1	0.1<A2<0.5	≥0.5
Insect damaged grain (max. %)	≤3.0	3.0<A2<5.0	≥5.0
Discoloured grain (max. %)	≤4.0	4.0<A2<6.0	≥6.0
Other coloured grain (max. %)	≤2.0	2.0<A2<3.0	≥3.0
Broken grain (max. %)	≤2.0	2.0<A2<3.0	≥3.0
Foreign matter (max. %)	≤1.0	1.5<A2<1.5	≥1.5
Total defects (max. %)	≤14.1	14.1<A2<21.0	≥21.0

In addition, it was decided to allocate grades using the more lenient approach of the "Total Defects", which allows compensation of one type of defect by another, as opposed to the stricter method of requiring that all the defective fractions be within their own limit.

Weight and percentage of all defective fractions, and grade allocated, were recorded for each sample. An overview of the results of the analysis of these figures is given in the next section, and more details are provided in Appendix 1. All samples were labelled, heat-sealed in plastic bags and stored in a locked container for reference.

Feedback on grain quality was not shared with the SCPs early enough in the marketing season to have an effect on the quality of the grain purchased, but it allowed the pilot to check feasibility and assess the quality of the feedback.

[6] Maize Grain Specifications (2nd revision) ZS 186:2004 Zambian Bureau of Standards

2.1.1.3 Results

The table below shows that more than 97 percent of the consignments[7] from SCPs were graded as A1, 2.3 percent were graded as A2 and only 0.4 percent were of grade B.

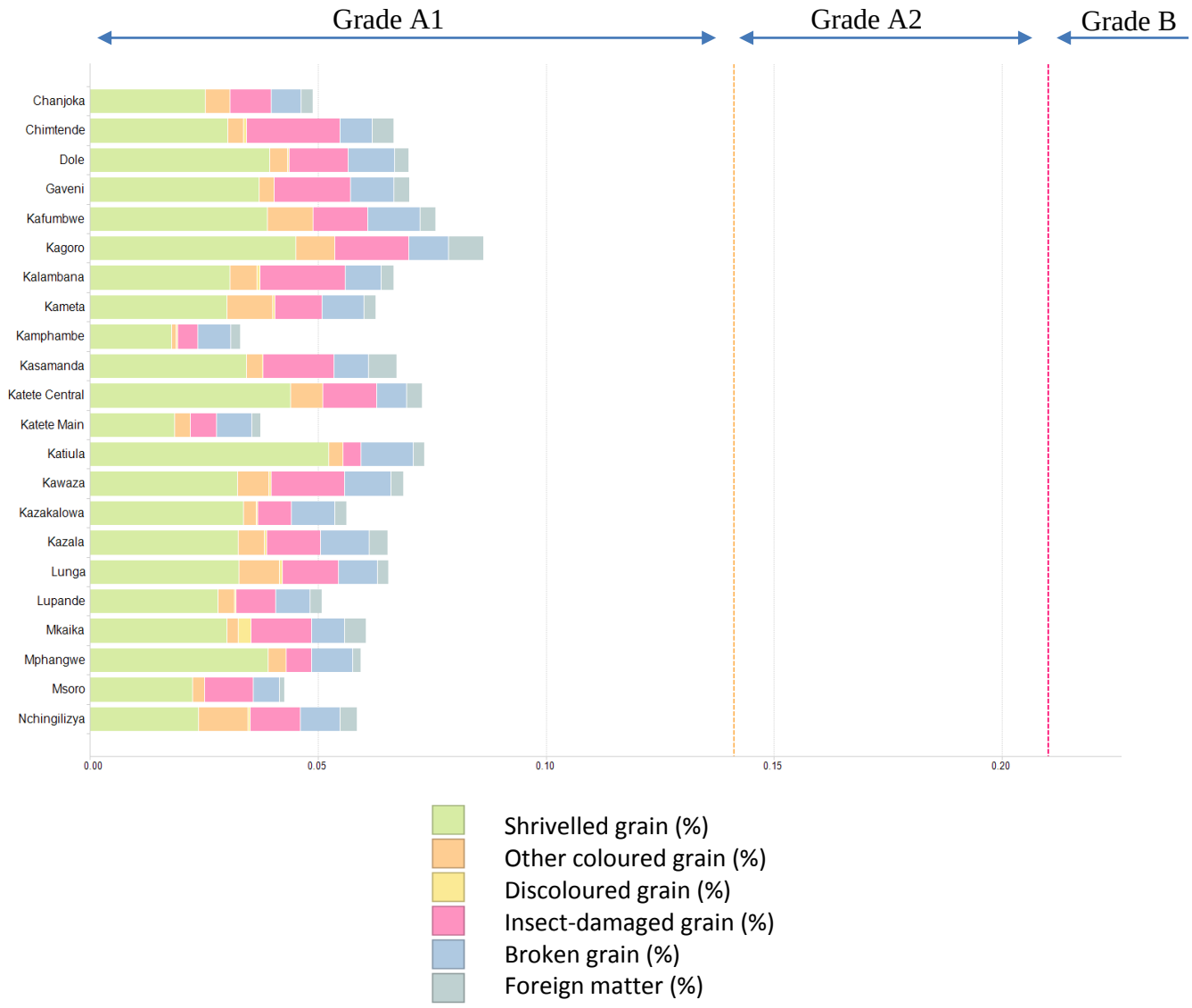
Table 3: Grades per SCP

Satellite	A1	A2	B
Chanjoka	15		
Chimtende	40		1
Dole	24	1	
Gaveni	22		
Kafumbwe	16	1	
Kagoro	33	6	
Kalambana	31		1
Kameta	34		
Kamphambe	23		
Kasamanda	30	1	
Katete Central	14		
Katete Main	1		
Katiula	32		
Kawaza	12	1	
Kazakalowa	27		
Kazala	13	2	
Lunga	25		
Lupande	19		
Mkaika	19		
Mphangwe	22		
Msoro	21		
Nchingilizya	72	1	
Grand total	**545**	**13**	**2**

The diagram below shows the percentage of each defective fraction as an average from each SCP.

[7] A consignment is the quantity of maize carried by one truck for one journey.

Figure 5: Percentage of Defectives for Each SCP



For more detailed results of the grading, please see Appendix 1.

2.1.1.4 Recommendations

- Sampling and visual assessment of quality must be implemented at all levels of FRA operations.
- Grading can be implemented more widely – perhaps at a provincial or national level. It has to be part of the mission of a Quality Control team.
- A training programme and monitoring schedule for grading activities should be developed and incorporated in the FRA procedures.
- Grades definition should be revised: FRA management should confirm the use of the Zambian Standard and define how the grades are to be implemented.

2.1.2 Fumigation

2.1.2.1 Observations

Unsuccessful fumigations (i.e. fumigation exercises that would fail to control the pests due to inadequate equipment, processes or handling) were observed at Chimtende SCP. In addition, there were indirect observations of instances where insect pests were found alive after fumigation, or clear failings, e.g. punctured tarpaulins, insufficient numbers of sand bags etc.

2.1.2.2 Training

Two training events were organised at Katete depot:

A theory-only training was organised with the Katete district-appointed fumigator, Nemesis Ltd, and the District Depot Marketing Assistant.

A practical training event was organised on 8 September, attended by a contracted fumigator from Chipata, Kumawa Agri Services, the provincial Pest Controller, and various FRA staff from the district depot. A stack of 507 mt was fumigated in Warehouse Number 1.

Figure 6: Fumigation at the FRA Depot in Katete

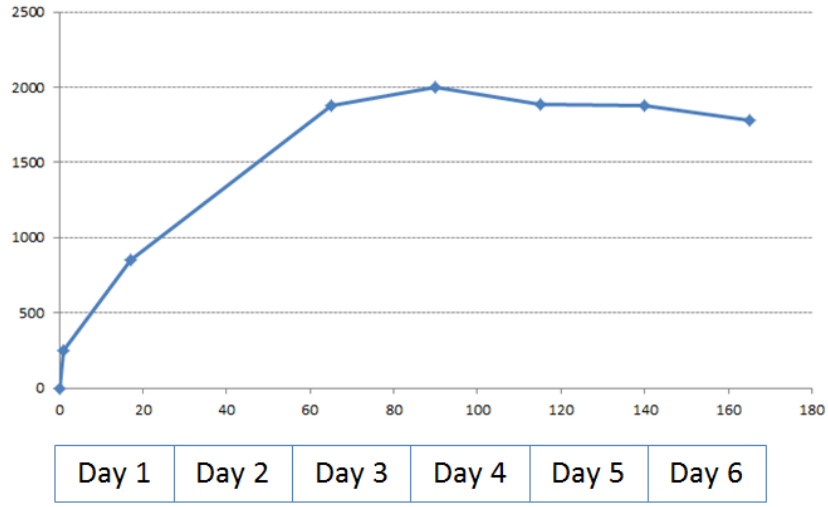
The training event itself highlighted several areas where improvements are required, including:

- Equipment availability and quality
- Knowledge and skills
- Procedures and checks

- Oversight and responsibility
- Safety for all personnel present

The training fumigation also demonstrated that successful fumigation is possible if the guidelines are followed appropriately, as the following graph shows:

Figure 7: Phosphine Concentration Over Time During Training Exercise



Phosphine gas concentration was maintained at a high level over several days, proving that the gas-tight enclosure was correctly set. However, the slow release of gas and the very high concentrations reached indicate that the number of phosphine tablets used (at the FRA recommended dose of 5 tablets per tonne) far exceeds recommended dosage rates of 2 to 3 tablets per tonne.

2.1.2.3 Recommendations

At the time of fumigation:

- Required equipment brought by fumigators or rented from FRA
  - Tarpaulins – these need to be in good condition, they also need to be checked carefully for holes prior to each fumigation and existing holes must be mended.
  - Glue and patches (or adhesive patches) must be available in sufficient quantity and quality
  - Personal safety equipment: gas masks with valid phosphine cartridge, gloves
  - Phosphine tablets and trays on which to spread the tablets
  - Sand-snakes or material to make them
  - G clamps or equivalent to join several tarpaulins if needed
- Appropriate oversight by FRA staff
- Up-to-date written Standard Operating Procedures for fumigation, to be followed by contractor and monitored by FRA staff
- Use of phosphine meters to ensure successful fumigation

In order to ensure that the above is always present for fumigations, the following, more generic recommendations are made:

- Compulsory training of fumigators contracted by FRA, with a yearly training schedule and certification scheme
- Above training scheme owned and validated by the Zambia Pest Controllers Association
- Checklist for monitoring by FRA staff, including the use of phosphine meters
- Blacklisting of fumigators who repeatedly fail during regular monitoring

2.1.3 Monitoring & Evaluation

2.1.3.1 Plan

Given the short marketing season in 2013, the project team was unable to conduct the full monitoring plan during the project and therefore focused on project evaluation only. This plan included:

- the quantitative data captured by the Quality component of the pilot (results summarised in Section 3 and presented in Appendix 1)
- the quantitative data captured within the M-Tech component (presented in Section 4)
- interviews with the main staff involved in the pilot (results summarised in this section)

2.1.3.2 Activities

Forty SCP staff were interviewed and their answers are summarised in the following section.

2.1.3.3 Results

The SCP staff whose answers are presented below were mainly young people with less than or up to a year of employment (not necessarily with FRA). Approximately 60 percent had been employed by FRA in previous year(s). The questionnaire aimed at recording their perceptions on their duties and on the pilot.

High level results can be summarised as follows:

- **SCP Staff – General Background**

The typical SCP buyer is young, with limited education and work experience: Almost 70 percent of the SCP buyers are aged between 20 and 30 years, 60 percent are male, 60 percent are educated to grade 12, and 20 percent have a professional certificate.

The majority of buyers, 60 percent, have worked for the FRA before, but 22 percent of the buyers had no previous work experience. Eighty percent, said they understand their duties, whilst 25 percent admitted having no knowledge about their contract as an FRA buyer.

- **Training Received by SCP Staff as Part of the Pilot**

Almost 70 percent of the buyers said that the training they had received within the pilot was useful in exercising their duties.

- **SCP Staff Perception of Maize Quality Issues**

SCP buyers were split on the issue of ease of the quality checks they had to perform: 55 percent of them found these easy, the others did not. Seventy percent of the buyers claimed to

have checked every bag that they purchased, the rest recognised that they had not. Just below 60 percent claimed to have sieved every bag. However 30 percent of the buyers said they had not rejected any maize during the marketing season.

The most common reason for rejection (44 percent) was insect damage alone, and 64 percent of the buyers mentioned insect damage as at least one of the reasons for rejection.

Up to 60 percent of the buyers reported that the farmers complied with the new quality requirements, although half of these said the farmers also complained about the requirements.

- **SCP Staff Perception of the M-Tech Pilot Component**

Three quarters of the SCP buyers said they had never used an Android tablet before, but only 8 percent of them said they were not able to use the Android tablet for sending/receiving emails.

Network performance was described as poor by 45 percent of the buyers. The preferred networks were MTN (50 percent) then Airtel (30 percent).

The SCP buyers were told to enter data on the system and synchronise it at 8am, 12 midday and at 5pm. They found this difficult and 70 percent of them suggested that it would be better to do it after work.

Interestingly, only 6 percent of the buyers said they spent the whole day using the Android tablet, whilst 70 percent said they spent less than an hour on the Android tablet every day.

Half the buyers said that the main benefit of the system was fast communication and reporting. Other benefits cited, but by much smaller numbers of buyers, include: quick dispatch of stock, reduced fraud and good data storage.

30 percent of the buyers reported not experiencing challenges with the M-tech equipment. The most common challenge reported was with the solar charger and battery (40 percent) and then with the mobile network (19 percent).

Half the buyers said they could think of no disadvantages of the system. While 20 percent said that poor internet was an important disadvantage. Smaller numbers said the system was time consuming, that they suffered loss of data and that the weather caused problems.

Forty percent of the buyers could not think of a way to improve efficiency of the system; 10 percent suggested that there should be an FRA project team working with them in the district. In terms of support to do their work, only 11 percent reported not needing help and 64 percent of the buyers said they needed help from the Summum support team often.

- **SCP Staff Perception on Reporting their Mobile Technology Hardware and Software issues to M-Tech pilot staff and the support they received**

How did the SCP buyers report their issues concerning the mobile technology hardware and software? One third reported issues in person, when they visited the district office, 14 percent did not report issues. Small numbers of buyers would use email, SMS messages, talk to WFP staff or use a combination of these methods.

One third of the buyers reported that their issues were not resolved, 15 percent reported immediate resolution, 12 percent had to wait a month, and 6 percent two months.

- **SCP staff general impression of the pilot and recommendations:**

One third of the buyers said that the main impact of the pilot was to reduce shortages, for 23 percent of them it was improved data entry, good quality of maize purchased by FRA or ICT skills development.

All buyers recommended that the pilot should continue or be up-scaled to include the rest of the country.

2.1.3.4 Recommendations

A similar collection of data and subsequent analysis should be part of normal FRA activities. The forthcoming FRA M&E department should be trained to take on this responsibility.

2.2 Data Collection using Mobile Technology

The Mobile Technology component of the pilot involved designing a software solution for capturing, storing, and merging information from all the maize purchases at SCP level in order to make this information available to the district level. In addition to such data as quantities purchased, farmers' details, and stocks, the software also captured information about transport between SCPs and the district depot. The software was designed to allow monitoring in near real-time and reporting.

The objectives of the M-Tech Component were to:

1. Develop and test an effective mobile data collection platform used at the SCP to enter the data available and transmit it to the district office on a daily basis for improving the data capture, collection, reporting and logistical planning activities of the FRA.
2. Reflect on possible up-scaling of the approach.

Android tablets with the software solution installed were given to the SCP buyers and a dashboard application providing access to and an overview of all the merged data was installed on the computers at the FRA district office.

This section presents the Mobile Technology Solution, then the transport system; the results of the pilot are analysed in the third part of this chapter where the monitoring and evaluation of the system is presented. The final part of this chapter will present the recommendations for up-scaling the solution.

For the technical design and design process of the system we refer to the pilot phase design report.

2.2.1 Piloting the Mobile Solution

2.2.1.1 Mobile Solution in Detail

The software solution was developed for Android tablets so the SCP staff would record the data for daily stock position, farmer information and the amount of maize bought from farmers, as well as maize dispatched to the district depot. This data was entered into an Excel application called "Planmaker", installed on the tablets. When SCP staff saved the spreadsheet, the data was then sent over the mobile internet connection provided to each SCP, to a cloud-based storage. For the purpose of the pilot, Google Drive was selected as cloud

repository. Sending and synchronization of data was done through a program installed on the tablets, called "Foldersync", this application automatically saved and synchronized the data to the Google Drive cloud-based storage.

At the main district depot in Katete, the data entered by the SCP staff could be accessed through the Google Drive using an Excel application developed by Summum and called the Dashboard. The Dashboard updated the latest data from SCPs, merges all the individual SCP spreadsheets into one overview but still allowing staff to drill-in to the individual SCP level if required. FRA staff at the main district depot could therefore monitor all the incoming data from the SCP and this information could be used to request transport dispatches as needed.

The grain quality component of the pilot monitored the quality of grain coming into the main district depot and the system provided feedback to the SCP on the grade of each shipment.

The data flow of the system was as follows:

1. Data was entered at the SCP to record the daily stocks take, farmers' information, maize purchases, and dispatch data.
2. The data was saved and synchronized with the cloud storage on Google Drive.
3. At the Main Depot the data could be accessed through the Dashboard.

The mobile data collection system was installed on 7 inch Samsung Galaxy Android Tablets, chosen for their good quality, large touch screen, and availability in Zambia.

All Android tablets were set up with one SIM card (MTN or Airtel depending on network connectivity) to access the internet and therefore Google Cloud. A keyboard and cover were also included to protect the tablet from harsh environmental conditions at the SCP. None of the SCPs had electricity, so in order to charge the tablets, the BBOXX BB5 battery and solar kit was selected for charging the tablets.

Data entry on the Android tablets:

Data entry on the Android tablets was done using three Excel sheets, namely: maize purchases, daily stock and dispatch data. The grain quality feedback to the SCPs from the main district depot was done through the quality feedback Excel sheet.

Below are shown the three data entry sheets and the quality sheet for the feedback:

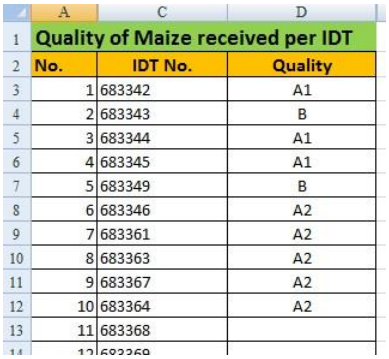
Figure 8: Maize purchase Excel sheet on the Android tablet

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	DepId1		Lupande	Total:	0	0	0.0			Account		Cumm.	Locked	
2	No	Date	Farmer name	NRC farmer	PRN No	Bags	Tonns	Value	Bank	No.	Branch	Purchases		Verified
3	1											0		
4	2													
5	3													
6	4													
7	5													
8	6													
9	7													
10	8													

Figure 9: Daily stock Excel sheet on the tablet

	A	B	C	D	E
1	DepId1	Lupande	701	28-Jul-2013	Locked
2	Date	Opening stock	Closing stock	Comments	Verified
10	28-Jul-2013	501	701		
11	29-Jul-2013				
12	30-Jul-2013				
13	31-Jul-2013				
14	1-Aug-2013				
15	2-Aug-2013				
16	3-Aug-2013				
17	4-Aug-2013				
18	5-Aug-2013				
19	6-Aug-2013				
20	7-Aug-2013				

Figure 10: Quality feedback of the maize received to the SCP



	A	C	D
1	Quality of Maize received per IDT		
2	No.	IDT No.	Quality
3	1	683342	A1
4	2	683343	B
5	3	683344	A1
6	4	683345	A1
7	5	683349	B
8	6	683346	A2
9	7	683361	A2
10	8	683363	A2
11	9	683367	A2
12	10	683364	A2
13	11	683368	

Figure 11: Excel sheet for the dispatch on the Android tablet

	A	B	C	D	E	F	G	H	I	J
1	DepId1		Totals:	0		0	0	Lupande	Locked	
2	No	Date	Loading Order	Transporter	Transporter Id	50 Kg Bags	Metric Tonns	IDT Form No.		Verified
3	1									
4	2									
5	3									
6	4									
7	5									

The dashboard application at the district office provided quick access to all the data, the data in the application was updated as soon as the user opened the dashboard or manually refreshed the dashboard data. The entry point for the user of the dashboard was the overview sheet of all the data entered by the SCPs.

Figure 12: Overview sheet of the dashboard

	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
				TOTAL MAIZE PURCHASES					TOTAL DISPATCHED				CALCULATED STOCK			DAILY STOCK TAKE		
	Date: 21-Jul-2013		Load purchase file	Bags: 0				Load dispatch file	Bags 0				Bags 0		Load stocktake File	Bags: 0		
				Tons: 0.00					Tons 0.00				Tons 0.00			Tons: 0.00		
	Depot details			Purchase details					Dispatch details				Stock details			Daily stock details		
	Id	Name		No. pur	last purchase	Quantity Bags	Tonns		No. Disp.	Last dispatch	Quantity Bags	Tons	Quantity Bags	Tons		Last Stock take	Quantity Bags	Tons

The user of the dashboard file could drill-in[8] the data of individual SCP by selecting it within the dashboard.

2.2.1.2 The Mobile Component's Transport System in Detail

The transport system for the Mobile Component was developed based on the FRA system previously in place at the district for recording the transport data. The newly developed transport system, also Excel based, contained the following elements:

[8] Drill-in refers to accessing lower level details in a database

- A dashboard
- Data entry fields for:
    - Incoming transport
    - Outgoing transport
    - Maize sales (outgoing maize)
- Reports:
    - Stock ledger
    - Overview of the dispatch data submitted by the SCPs
    - Transporter performance
    - Loading order performance
    - Satellite depot performance
    - Deliveries performance
- Settings for:
    - Loading orders incoming
    - Loading orders outgoing:
    - Deliveries orders
    - Transporter
    - Customers for deliveries
    - Destination for outgoing loading orders

System users were provided with an overview of all the elements of the system through the dashboard. The procedure for using the system was:

1. The user first defined the system data:
    a. Loading orders incoming transport
    b. Loading orders outgoing transport
    c. Delivery orders
    d. Transporter details
    e. Destination details
2. The user entered the incoming and outgoing transport details (loading orders, delivery orders, transporter details and destinations were selected from a drop down menu)

The use of drop down menus greatly reduced data input errors and improved the speed of data entry.

The system also uploaded the dispatch data from the SCPs, allowing it to track trucks that left the SCPs and showing if trucks actually arrived at the district depot.

Figure 13: Data Entry Sheet for Incoming Transport

	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA
1	ATA				WAREHOUSE MANAGER: FOOD RESERVE AGENCY																
2	RN PROVINCE				INCOMING - IDT & GRN										Total Kg:	0					
3															Total Bags:	0					
4	SOURCE		IDT				GRN				DESTINATION		VARIANCE		QUALITY	CUMMULATIVE IN			FIELD DATA		
5	DEPOT	L/D Or	IDT	Bags	Kg	Gir	GRN	Date	Bags	Kg	DEPOT	L/D	Kgs	Bags		Bag	Kg	Che	Truck	Left Sat De	
84	Kalambana	8559	983116	450	22,500					0	KATETE MAIN		450	22,500	5	0	0			7-Aug-13	DepId12
85	Kalambana	8581	983117	320	16,000					0	KATETE MAIN		320	16,000	1	0	0			8-Aug-13	DepId12
86	Kalambana	8581	983118	300	15,000					0	KATETE MAIN		300	15,000	5	0	0			9-Aug-13	DepId12
87	Kalambana	8559	983119	598	29,900					0	KATETE MAIN		598	29,900	5	0	0			9-Aug-13	DepId12
88	Kalambana	8581	983120	320	16,000					0	KATETE MAIN		320	16,000	5	0	0			11-Aug-13	DepId12
89	Kalambana	8581	983121	300	15,000					0	KATETE MAIN		300	15,000	5	0	0			13-Aug-13	DepId12
90	Kalambana	8597	983122	450	22,500					0	KATETE MAIN		450	22,500	5	0	0			15-Aug-13	DepId12
91	Kalambana	8597	983123	700	35,000					0	KATETE MAIN		700	35,000	5	0	0			15-Aug-13	DepId12
92	Kalambana	8597	983124	450	22,500					0	KATETE MAIN		450	22,500	5	0	0			15-Aug-13	DepId12
93	Kalambana	8581	983125	300	15,000					0	KATETE MAIN		300	15,000	5	0	0			15-Aug-13	DepId12
94	Kalambana	82004	983126	400	20,000					0	KATETE MAIN		400	20,000	5	0	0			15-Aug-13	DepId12
95	Kalambana	8581	983127	320	16,000					0	KATETE MAIN		320	16,000	5	0	0			16-Aug-13	DepId12
96	Kalambana	82004	983128	400	20,000					0	KATETE MAIN		400	20,000	5	0	0			17-Aug-13	DepId12
97	Kalambana	8597	983129	600	30,000					0	KATETE MAIN		600	30,000	5	0	0			17-Aug-13	DepId12
98	Kalambana	8597	983130	450	22,500					0	KATETE MAIN		450	22,500	5	0	0			18-Aug-13	DepId12
99	Kalambana	8597	983131	450	22,500					0	KATETE MAIN		450	22,500	5	0	0			19-Aug-13	DepId12
100	Kalambana	82004	983132	700	35,000					0	KATETE MAIN		700	35,000	5	0	0			21-Aug-13	DepId12
101	Kalambana	8581	983133	228	11,400					0	KATETE MAIN		228	11,400	5	0	0			23-Aug-13	DepId12
215	Kalambana	8597	983918	260	13,000					0	KATETE MAIN		260	13,000		0	0			6-Aug-13	DepId12
222	Kalambana	8597	983925	260	13,000					0	KATETE MAIN		260	13,000		0	0			9-Aug-13	DepId12

The system was able to generate the following reports:

- Stock ledger
- Overview of the dispatch data submitted by the SCPs
- Transporter performance
- Loading order performance
- SCP performance (volumes of maize transported out of the SCP)
- Deliveries performance

The screenshot below shows the report for a loading order performance for incoming transport.

Figure 14: Loading Order Performance for Incoming Transport

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	LOADING ORDERS INCOMMING PERFORMANCE					IDT			GRN			VARIANCE		CUMMULATIVE	
2				No.	Date	IDT No.	Bags	Kg	GRN No.	Bags	Kg	Bags	Ton	Bags	Ton
3	SELECT LOADING ORDER:	8564		1	0-Jan-00	983628	300	15,000	0	0	0	0	300	0	0
4	Transporter	Eras General Dealers		2	0-Jan-00	983502	0	0	0	0	0	0	0	0	0
5	Depot	Kazala		3	0-Jan-00	983503	450	22,500	0	0	0	0	450	0	0
6	Contracted [Bags]	4159		4	0-Jan-00	983504	500	25,000	0	0	0	0	500	0	0
7	Transported [Bags]	0		5	0-Jan-00	983505	500	25,000	0	0	0	0	500	0	0
8				6	0-Jan-00	983514	300	15,000	0	0	0	0	300	0	0
9	Balance [Bags]	4,159		7											
10				8											
11				9											

2.2.1.3 Implementation of the Solution

Prior to deployment, the software solution was developed and tested in Lusaka; the tablets were purchased and fitted with SIM cards and a half-day training module was developed.

In Katete, the deployment started a week before the start of the buying season. The software was set up on the Android tablets and the training module was delivered to all the SCP buyers by the FRA district staff who had been briefed by staff from Summum, an ICT consultancy. SCP buyers were provided with one tablet and associated charging equipment per SCP.

The dashboard program was installed on two laptops provided by FRA to the district office. A wireless MTN router was installed in the office to provide internet access. Because of the

high data usage of the system, the internet provider was later changed from MTN to Airtel as the latter offered a subscription with unlimited data usage.

During the first three weeks of the pilot one FRA staff member and the Summum developer of the platform worked on the system to make a variety of required changes. With the very short development period of just six weeks, a number of issues were found on implementation. These issues are discussed in the M-Tech M&E section. The main challenge in designing this system was that the precise reporting requirements were not fully understood by the project team. In addition, there were specific formats differing from the regular templates that had to be produced on occasion. These specific formats correspond to external requests made to the FRA.

During the three months of the marketing season in Katete, one Summum support staff was based at the main district depot to provide support; this support was both for the SCPs and the staff at the main district office. The support required at the main district office was significantly higher than for the SCPs. The number of Summum support staff was increased to two in the second month to cater for the high workload as the support staff were not only providing support but also were involved in the running of the system and data verification required by the system. Data entry and data verification would normally be the responsibility of the district depot staff, but during the pilot, Summum staff had to cover these activities.

During the last two weeks of the pilot the support staff was also involved in interviewing all the FRA staff, the district commissioner, transporters and other stakeholders on their views and experiences of the system. The findings are described in the evaluation of the M-tech system section.

An additional challenge in the design of the Mobile solution was that there were a number of technical issues requiring constant monitoring of the system. These were issues such as blocked Google accounts, link errors between different Excel sheets and old files overwriting new files.

2.2.1.4 Adoption and Usage of the Solution

Usage and adoption of the system by the SCP staff and the staff at the main district depot responsible for the maize purchase data and the transport system is discussed here.

The SCPs

For the first 10 days, most SCP staff did not use the new M-Tech system appropriately. Data submission was not done in a timely manner, as staff perceived it to be low priority compared to their other duties. This was corrected through communications on requirements and better clarity of duties by the District level pilot staff.

In addition, during the first three weeks of the marketing season, incorrect stock data was submitted by most SCPs. Investigations showed that stock-taking was not well understood, and corrective training was required.

After these initial teething problems, most SCPs submitted accurate data in a timely manner using the M-Tech system.

The district depot dashboard

The district depot dashboard was developed and fine-tuned by the project staff. However it was not used as much as could have been because of pressures of the marketing season,

which meant that there was not enough time to embed the new system in the normal FRA procedures.

The transport system

The transport system required a lot of work at the beginning of the pilot before it reached a stage where it could be used by FRA staff. The main challenge was that it could not provide the reports required by the province; as a consequence, FRA staff still used their old Excel spreadsheets from the previous season.

Despite finalizing the transport system and training the FRA staff, the system was still not used because it would require re-entering all the data which would cost a lot of time.

2.2.2 M-Tech Monitoring & Evaluation

2.2.2.1 Plan

A monitoring and evaluation plan for the M-Tech component was developed before the start of the pilot and refined during the beginning of the pilot. This plan was presented in an M-Tech M&E design report.

The M-Tech monitoring and evaluation has two functions. Firstly to monitor the system in order to provide support and rectify problems with the system and secondly to evaluate the two main objectives of the M-Tech component. These objectives were:

(1) to develop and test an effective mobile data collection platform used at the SCP to enter the data available and transmit it to the district office on a daily basis for improving the data capture, collection, reporting and logistical planning activities of the FRA; and

(2) to reflect on possible up-scaling of the approach.

The sources of data were weekly questionnaires sent to the satellite depots and the system log book where any issues or changes of the system were recorded. At the end of the pilot all users and stakeholders affected by the pilot were interviewed on their views and experiences of the system.

Three distinct elements were studied, and for each the following outcomes were considered:

1. Hardware, Software Design and Support to the System
    - Outcome – All users on the system were able to connect to the internet which allowed them to use the solution
    - Outcome – The equipment at the satellite depot remained in good working condition and could be used for project purposes
    - Outcome – All users were trained effectively to use the platform

2. Data Quality and Effectiveness of the System
    - Outcome – The solution captured and presented data in the required format
    - Outcome – The solution captured data accurately
    - Outcome – The solution captured data in a timely manner
    - Outcome – The system performed with minimum support requirements

3. System adoption and evidence for scale-up

- Outcome – The system adopted at the district for capturing maize purchase data
- Outcome – The users adopted the system for capturing transport data
- Outcome – The quality feedback of the system was adopted and effective
- Outcome – The design and implementation of the system allow for scaling up

2.2.2.2 Conclusions and Recommendations

The M-Tech component of the pilot proved the concept that the use of mobile technology can improve data collection and usage within FRA operations. However the pilot also made very clear that there are numerous challenges to achieve this. One of the findings of the pilot was that the solutions did not match fully the user requirements of the FRA both at district and provincial level.

The system design did not address all the user requirements, therefore the first step in the scale up of the project would be to redesign the system, starting with the system specifications. This needs to be undertaken with the involvement of district, provincial and head office staff.

From the findings of the pilot we recommend that the districts will be responsible for data entry and cleaning; the data should be accessible by the province and head office, and the system should be able to generate the required reports.

Specific recommendations for scaling up would be as follows, in terms of design, implementation, technical and staffing issues:

Design

The system needs to address two areas:

- capturing, collecting and transmitting data from the SCPs using the mobile technology and displaying this data in the correct format to the users,
- capturing transport data at district level.

For the collection of data from the SCPs the pilot system captured the data correctly as it follows closely the paper trail currently in place. During the pilot we found that the data collected is the data required at the district and provincial levels. However the data should be available at the head office, provincial and district levels.

When designing the system specifications, the specifications of the solution for the district, the province and head office should be clear in terms of:

- What is the data collected
- Who needs to see what data
- Who is responsible for the data verification
- What are the reports required
- Who will log the Goods-Received Notes (GRN) and Inter-Depot Transfer Notes (IDT)
- What will be done in the system with incorrectly filled in PRC and IDT forms

An important role of the districts will be to make sure that the SCPs submit their data.

For the design of the transport system it is important to define which data needs to be captured, by whom and how it is reported.

The systems specifications of the transport system should answer the following questions:

- What data needs to be captured by the system

- Who is responsible for the data entry
- Who is responsible for the data verification
- What are the reports required and by whom
- Who will be responsible for entering the following data:
    - Incoming Loading orders
    - Incoming IDT
    - Goods Received Note (GRN)
    - Goods Issued Note (GIN)
    - Outgoing loading orders
    - Outgoing Inter-Provincial Transfer Notes (IPTs)
    - Deliveries orders
    - Transporter details
    - Customer list for the deliveries
    - Destination for outgoing loading orders

Implementation
When developing and implementing a system for the FRA it is absolutely necessary that the system should be nearly fully functional by the start of the buying season, otherwise it will seriously disrupt FRA operations. Preparations should include communications, training, teams' set-up, equipment and logistics.

Technical Issues
The system requires a centralised management structure in order to allow the scale up of the platform; this will require that the system has a central database that can be accessed remotely.

Organisational Issues
The organisational issues are discussed in the M-Tech M&E part of this report. It is however important to highlight the need for clear responsibilities and procedures at all levels. Another important requirement is the improvement of the ICT infrastructure at district level (computers and internet connection) and for archiving and filing of data.

ICT Skills
SCP staff submitted insufficient data through the new system at the beginning of the pilot. This was likely caused by insufficient training on the new system and lack of full embedding of the new system within FRA processes. There is a need for enhanced training and technical support for the SCP staff as well as full embedding of any new system into existing FRA processes.

We found that the computer skills of some of the depot staff were limited (FRA had employed temporary staff for data entry at district level) and data recording on the pilot system was often inaccurate, data was often missing, incorrect or had been entered twice in the system. There is need for any new system to be simple to use at the district level and it needs to allow for the monitoring of the data submitted, at the provincial and national levels.

3 Observations and Findings

3.1 Operational Issues at Satellite Collection Points

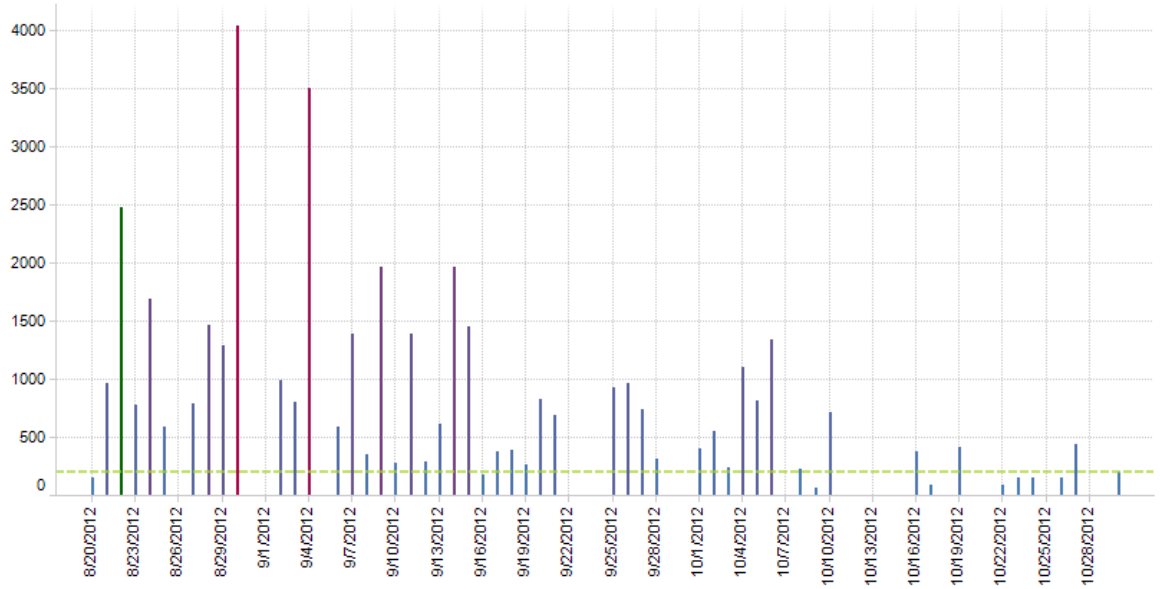
Although the reduced remit of the 2013 pilot focused on the district depot operation, some observations made on SCP operations were made from an analysis of 2012 data.

3.1.1 Peak Times vs Quality

If too many bags of maize are purchased at a SCP in a given day, it becomes impossible to ensure the quality of the maize.

Using data captured during the 2012 marketing season in Katete district, it is clear that some SCPs purchased far more maize on specific days than they could have checked. For example, the figure below shows daily purchases at the Nchingilizya SCP. The peaks shown in red correspond to days with purchases of over 4,000 and 3,500 bags respectively:

Figure 15: Number of bags purchased at one SCP, per day (2012 season)



To illustrate the problem, the following calculations show the number of bags that could be sieved during an 8 hour working day, with 1 or 2 sieves at a given SCP (all SCPs have been provided with 1 sieve only), and based on the assumption that sieving a 50kg bag of maize would take 1, 3, 5 or 10 minutes. In the highly unlikely best-case scenario, where skilled operators were able to sieve (and properly clean) a 50kg bag in only 1 minute, and the SCP had 2 operational sieves, the maximum number of bags that could be checked in a day would be under 1000. It is clear that when daily purchases reach 4000, the majority of the bags are not checked, let alone cleaned.

Table 4: Number of bags that could be checked per day, as a function of the time taken to sieve and the number of sieves available

Time to sieve 1 bag	Number of sieves: 1 sieve	2 sieves
1min	480	960
3min	160	320
5min	96	192
10min	48	96

To avoid purchase of maize that has not been checked and cleaned, it is therefore important that deliveries of maize to SCPs are spread over time, to remove peaks. Possible solutions could be tested:

- Pre-registration of farmers, with an individual allocation on specific day(s). The allocation of days where farmers are invited to sell their maize at the SCP could be done randomly as a raffle,
- Provision of more sieves at SCPs,
- Sensitisation of farmers to increase the quality of maize brought to SCPs.

3.1.2 Deliveries of Large Quantities

In a similar manner, analysis of data from the 2012 marketing season[9] provided by Katete district staff, showed that a few named individuals sold very large numbers of bags (more than 1,000). It is likely that these individuals purchased and aggregated maize in order to attain these high quantities, despite the fact that the FRA's mandate is to purchase directly from small-scale farmers.

In reality, local traders offer a useful service to small-scale farmers by buying their maize earlier than the start of the FRA marketing season, or by taking care of the transport costs from the farm to the SCP.

But SCPs cannot take deliveries of large quantities of maize without compromising the quality checks. Solutions that could be tested include:

- Use of a national farmer's register at the point of purchase
- Creating a specific collection point for large quantities, with several sieves and available labour
- Ensuring that all maize sellers, farmers and/or traders, bring smaller quantities on any day. Sellers with large quantities would have to come over several days and spread their deliveries
- When dealing with sellers of large quantities, SCP buyers should involve their management

[9] Source: 2012 FRA market data obtained by WFP and NRI from the marketing assistant in Katete district prior to the commencement of the pilot project.

3.1.3 Set-Up of Satellite Collection Points

The suggestion for redesigning the SCP space, made in the first proposal for the Katete pilot, should also be revisited: it includes one specified entrance point, where a member of staff (buyer or inspector) receives the farmer, oversees the sieving of maize and its cleaning if required.

The maize is then re-bagged, in FRA bags and moved into the second area, where a second quality check takes place. This would be based on taking a random sample from the bags, before issuing the receipt of purchase. Bags are then stocked until they can be transported to the depot.

Two improvements at farmers' community level:

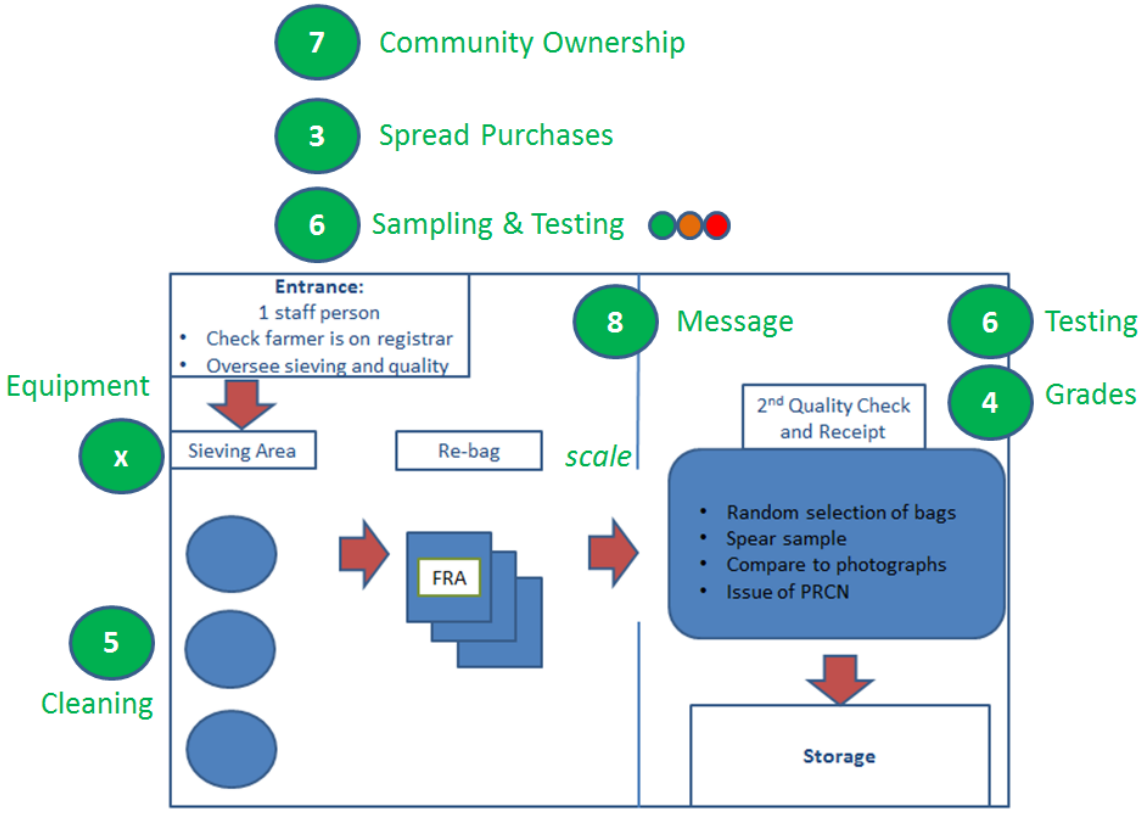
1 Farmer sensitisation
2 Provision of shellers

The following improvement points, relevant for SCPs, were discussed for the 2013 pilot:

3 Spread of purchases (Pre-registration, raffle)
4 Grain quality standard (A1, A2, B)
5 What to do if Grade B? (Clean)
6 Sample & Testing methods (Design sampling methodology & quick visual test)
7 Community ownership (Plan & organise)
8 Message (Plan & deliver)

However only points number 4 (quality standard and grades), 5 (cleaning if grade B) and 8 (message displayed at each SCP) were tested during the pilot.

Figure 16: Diagram Showing the Potential Improvements for SCP that were considered in the Pilot Design



3.2 Procedures & Processes

During the pilot, it appeared as if FRA's Operating Procedures, at SCP and District Depot level, were not available to staff. It was later revealed that the procedures are written but the operating procedures manual was not available, making it a *functional* absence of written Operating Procedures.

The FRA Standard Operating Procedures Manual is being compiled for release in mid-2015.

The functional absence of Operating Procedures makes it difficult for new staff to understand what their duties involve and how to do their job, it also makes it easy to forget or ignore some of the necessary tasks, leading to potential redundancies or gaps. For the organisation, it makes it very difficult to reflect on its operations and to improve them.

3.2.1 Firefighting

As an Agency of the Ministry of Agriculture receiving funds from the Ministry of Finance, the FRA's operating environment e.g. policy environment, funding, political economy etc. is complex and the Agency implements policy decisions taken by these Ministries, and on which it has limited influence.

The nature of the Agency's mandate means that it needs to react – sometimes at very short notice – to decisions and strategies that it has no or little influence upon. This means that FRA must have the capacity to react quickly and effectively, and in a very flexible manner.

However, within the constraints of this situation, there are regular and predictable elements which can be planned for. For example, although the quantities and the timing of maize purchases are decided outside of the Agency, the fact that the FRA will buy maize from small scale farmers is a constant, and so is the fact that it will store this maize and transport it. A lot of these activities can be planned in advance, and staff in the field could prepare for them ahead of time: scales calibration, repairing sieves, shed maintenance and cleaning.

3.2.2 New Employees

During the pilot, it was possible to discuss with the SCP buyers and review with them their understanding of their job and the resources they could use to both develop this understanding and improve their skills. These appeared to be very limited.

Generally speaking, for any organisation, a proper induction programme is required for each level in the organisation. Written documents such as job descriptions, job aids, applicable Operational Procedures, management structure (including responsibilities and accountability lines), and of course contractual agreements, should be provided to each new employee. The appraisal plan should be discussed with new recruits from the start, and their responsibilities and accountability should be specified in writing and agreed upon.

For crucial employees such as SCP buyers, effective training in their responsibilities is extremely important. During their induction period, the new recruits, many of them having not worked for FRA before, need to receive appropriate hands-on training. The buyers should also be provided with training manuals that can be referred to afterwards.

3.3 Monitoring and Evaluation

The nascent Monitoring & Evaluation unit at FRA is likely to play a major role in collecting and analysing data and reporting. It will need to work in close collaboration with existing units which have the responsibility of data collection and analysis.

Together with the future rolling out of a nationwide real-time data system on purchases, quality, transport and storage, as tested in this pilot, this will lead the Agency to review its full process for data collection, analysis and reporting – and therefore the corresponding Operational Procedures – which should cover all activities from data recording by various operational functions, to data analysis and reporting by the specialised unit(s), to communication of results to internal and external audiences.

The increased amount of data, and the need to analyse it in real time, is likely to warrant a review of current FRA capacity, resources and procedures. Such a review must be an integral part of the scaling up proposal.

3.4 Safety (Chemical and Other)

During the pilot, chemical safety and health and safety areas of risks were noted, and it is highly recommended that these are monitored and managed through adequate procedures and training. Typical areas to look out for include fumigation, spraying, regular delivery of health and safety training and personal safety equipment.

3.5 Warehouse Management

Some basic warehouse management processes need to be remembered. Below is a list of points that were noted to be in need of attention during the pilot:

3.5.1 Shelf-life

In order to optimise storage, it is important to understand the concept of shelf-life: maize should only be kept for a limited amount of time in storage. The duration of storage is dependent on quality, with high quality (grade A1) being able to be kept for longer than lower quality (grade A2 or B). But in addition, proper stock rotation needs to be enforced using the 'First In, First Out' (FIFO) principle.

For shelf-life to be optimised, it is therefore crucial that:

- Maize of the same grade is stored as a stack
- Stacks are properly located in the warehouse, labelled and their location recorded on a ledger available at the depot management level.

3.5.2 Stacking

The manner in which stacks are built is important. Good stacking requires skill and attention to detail, but it allows for:

- Easy counting of bags for efficient and accurate stock taking
- Safe stacks that will not present risks to warehouse operators
- Easy and effective fumigation

Proper stacking will involve regular and predictable numbers of bags on well-defined levels, straight edges, appropriate space between the stack and the warehouse walls as well as

between stacks, and a size of stack that corresponds to the size of available tarpaulins so that fumigation can be made under one single sheet, greatly improving the chances of a gas-proof environment.

In addition, the creation of stacks with aeration gaps could be investigated, for its advantages in terms of ventilation and fumigation.

3.5.3 Maintenance / Cleaning

Warehouses in Katete district need regular basic maintenance: roof leaks and cracked walls need repairing, ground slabs with small cracks should be filled. Warehouses also need to be cleaned thoroughly and regularly to avoid dust accumulation on the internal walls that provide ideal hiding places for insect pests.

The area immediately outside warehouses needs also to be kept tidy and clean. In Katete, tarpaulins stored within a few meters of the warehouses were found to show signs of rodent damage indicating that rodents had been hiding in the roughly folded tarpaulins. There should be no hiding place promoting the presence of rodents near the warehouses.

3.5.4 General Maintenance and Stock Keeping of Equipment

It has proved quite difficult to know what equipment was available at the district depot, as no up-to-date list was maintained despite an asset register being in place. Equipment was often piled with little care, making it likely that damage would occur and it is proposed that an asset register is kept and updated regularly.

3.5.5 Handling

The pilot recommends that when maize of sub-standard quality arrives at district depot level from a SCP, it is isolated and cleaned before being moved in the warehouse. This would incur additional handling costs that the Agency will need to budget for.

3.5.6 Handbook

It is strongly suggested that a simplified and customised version of the WFP's *Training Manual for Improving Grain Postharvest Handling and Storage*[10] or the NRI's *Warehouse Management – A Handbook for Storekeepers of Food Aid*,[11] or similar manuals, is produced for the FRA. It would then be a requirement for the manual to be available to all staff with management responsibility at district and provincial levels.

3.6 Human Resources

In terms of Human Resources (HR) and human resource management, some improvements should be considered. Most of these have been touched upon in previous sections, but they will be detailed here in this HR-centric section.

The aim here is to help employees understand what their job involves, what they should be delivering and how they work in teams. Ultimately, it would be very desirable for the FRA to develop a strong sense of loyalty in its workforce.

[10] WFP, 2012. Training Manual for Improving Grain Postharvest Handling and Storage https://www.wfp.org/content/p4p-training-manual-improving-grain-postharvest-handling-and-storage

[11] Walker, D.J. & Farrell, G., 2003. Warehouse Management – A Handbook for Storekeepers of Food Aid http://www.nri.org/projects/publications/085954544X.htm

3.6.1 Roles & Responsibilities

During the pilot, the FRA staff most involved were the SCP buyers, freshly recruited, and the District Depot staff, some of whom were moved during the pilot. These staff would have greatly benefited from a clearer understanding of their own roles and responsibilities and those of their colleagues in order to maximise the efficiency of the work they have to accomplish.

It is suggested that a review of the documents listing staff's roles and responsibilities and their availability, is undertaken by FRA.

3.6.2 Contracts

SCP buyers must have a contract on the day they start so that they can understand their roles and responsibilities (see section above), and find it easier to develop a sense of loyalty to the organisation.

As an Agency of the Ministry of Agriculture receiving funds from the Ministry of Finance, the FRA's operating environment (e.g. policy environment, funding and political economy) is complex and its funding dependent on external decisions. This can make the release of funds in a timely manner difficult.

Salaries for SCP staff, including SCP buyers, should be paid on time to avoid unnecessary temptation when staff are not receiving regular wages but are dealing with valuable commodities on a daily basis. It would be beneficial to develop a more efficient system of management in the field, to expedite proper checks and validate employment in a timely manner.

3.6.3 Incentives and Recognition

Incentives should be used as a means to create and increase loyalty and to reward individuals who demonstrate above average commitment. Incentives should be part of the appraisal system, and they could be used at SCP and district level.

At depot level, incentives could be used to reward achievement of meeting quantity and quality monthly targets. Ideally, incentives should be given to the depot and then shared between all staff, to help build cohesion in the team as well as loyalty.

3.7 Planning

Looking at the scale of operations, it has been clear that the activities of the FRA in the field during the marketing season are very reactive. In many cases, officers go from attending one issue to attending the next one, with little time and energy left for normal management and preparation for forthcoming events.

Nationally, the FRA normally operates 75 holding depots, 1,200 SCPs in rural areas; this involves massive logistics in terms of crop transportation, securing and farmer payment.

As was remarked during the pilot, the FRA activities during the maize marketing season are comparable to army logistics. Planning approaches similar to those used by the army would most likely help deliver on time and on target.

3.8 Policy

It is well understood that the policies governing the activities of the Zambian Food Reserve Agency (FRA) are external to its authority, but learning from other national reserves could be used to suggest revision or clarification of these policies.

Appendix 2 is a literature review study of the Zambian FRA and its section B deals with relevant policies. Appendix 2 reviews examples of FRAs from countries such as Bangladesh, Egypt, Ethiopia, India, Indonesia, the Philippines, Qatar, Malawi, Tanzania, Tunisia, Switzerland as well as Zambia. It reviews external and internal factors that influence the success of strategic food reserves, making it clear that there is not one single solution, but a variety of approaches adapted to a variety of situations.

3.9 Embedding Lessons Learnt & the Way Forward

The technical improvements suggested by the pilot and presented in this report involve new processes which cannot be embedded efficiently into the existing system and organisational structure without some changes.

To build on the lessons learned during this pilot, a roadmap is required. It should focus on institutional review and development, looking at systems, processes, procedures, structure and skills to assess the current FRA. Such an assessment will inform a proposal to design a more efficient organisation, to deliver the benefits of up-scaling the lessons learned from the pilot project.

4 Conclusions: Limitations and Way Forward

This report presents the lessons learned from the pilot project. It details the two components of the pilot itself, and their specific results and then enlarges the discussions to the business model of the Agency.

4.1 Limitations of the Pilot Project

By its very nature, the pilot project had limitations in terms of time frame, geographical cover and resources such as:

- The visual assessment of grain quality at SCP level will need to be developed, and visual aids for all SCPs in the form of quality samples should be produced by the grading unit at district level
- It is not currently practicable or cost effective to test for aflatoxin on a routine basis. This would be an additional quality check which would greatly enhance the FRA's quality control
- The pilot showed that a limiting factor is the inability by some SCP staff to effectively use Android tablets because of varying levels of education and ICT experience. This caused an operational limitation during the pilot, but was part of the learning that the pilot was designed for
- Similarly the pilot revealed that the limited training received by SCP staff was a major cause of problems. This caused issues during the pilot, but was part of the learning that the pilot was designed for

- The pilot project was conducted in a lean year, and as such, the activities did not take place under the levels of pressure experienced in years when the FRA purchases more maize
- The pilot project took place in only one district. Katete district may not be fully representative of the whole country. While some of the lessons learned from the pilot will be relevant to much of the rest of Zambia, follow-up steps will need to consider context specificity.

4.2 Conclusions and Way Forward

The pilot showed that implementing a number of grain quality operations such as sampling and grading, and appropriate fumigation, is both possible and effective for ensuring that good quality maize is stored by the Agency.

The pilot implementation of the mobile technology component has shown that good quality data can be captured, collected, shared and used in real-time for the management of maize in terms of quality and quantity, during purchase, transport and storage.

The pilot also demonstrated that the impact of using both approaches is rapid and noticeable, and would more than cover returns on investment.

Based on these direct conclusions and preliminary suggestions from the pilot, a roadmap for scaling up the approach should be developed by a team constituted of FRA managers and external experts. The two components of the pilot can be mainstreamed within the FRA operation, but the approach taken during the pilot should not be merely replicated: some of the lessons learned show that it is possible to design more precise specifications for the systems and technologies, and it is unlikely to be efficient to use exactly the same approach nationwide. What worked well with good external support in one district may not necessarily work well at the global level and in a sustainable model.

The pilot team's overall recommendation for the way forward is therefore to engage firstly in a specification design phase, using lessons learned from the pilot, which will define the parameters of a strategic plan for scaling up the conceptual approach of the pilot – grain quality and M-Tech components – if not exactly the pilot itself. The specification design phase should also include detailed mapping of how the new systems and processes can best be embedded in the Agency's structure, with associated modifications.

It is the pilot's team belief that such a scaling up would be most beneficial to the operations of the FRA.

Appendix 1 – Feedback on Pilot from Local Authorities

The benefits of the pilot were summarised by the Katete District Commissioner:

> "*FRA must have done something correctly this year because to date I have not had farmers demonstrating at my door. Normally, by this time, I should have dozens of farmers waiting for me at the office every morning to complain about FRA; mainly complaints about farmers who delivered last being paid before those that delivered first. This year there has been none of that! I have had no complaints! I am the happiest DC in the country*."
>
> "*The Project was good as it sent signals to villagers who now know what is required at FRA in terms of standards and quality of maize. The objective of a clean food reserve has been achieved this season. The traders with their poor grain will go to the private sector where there is no quality control. However I think WFP should pull out gradually from FRA. There must be a transitional period during which checks and balances are still in place so that the system continues to work well. This way even the FRA will acquire the skills to run on their own*."

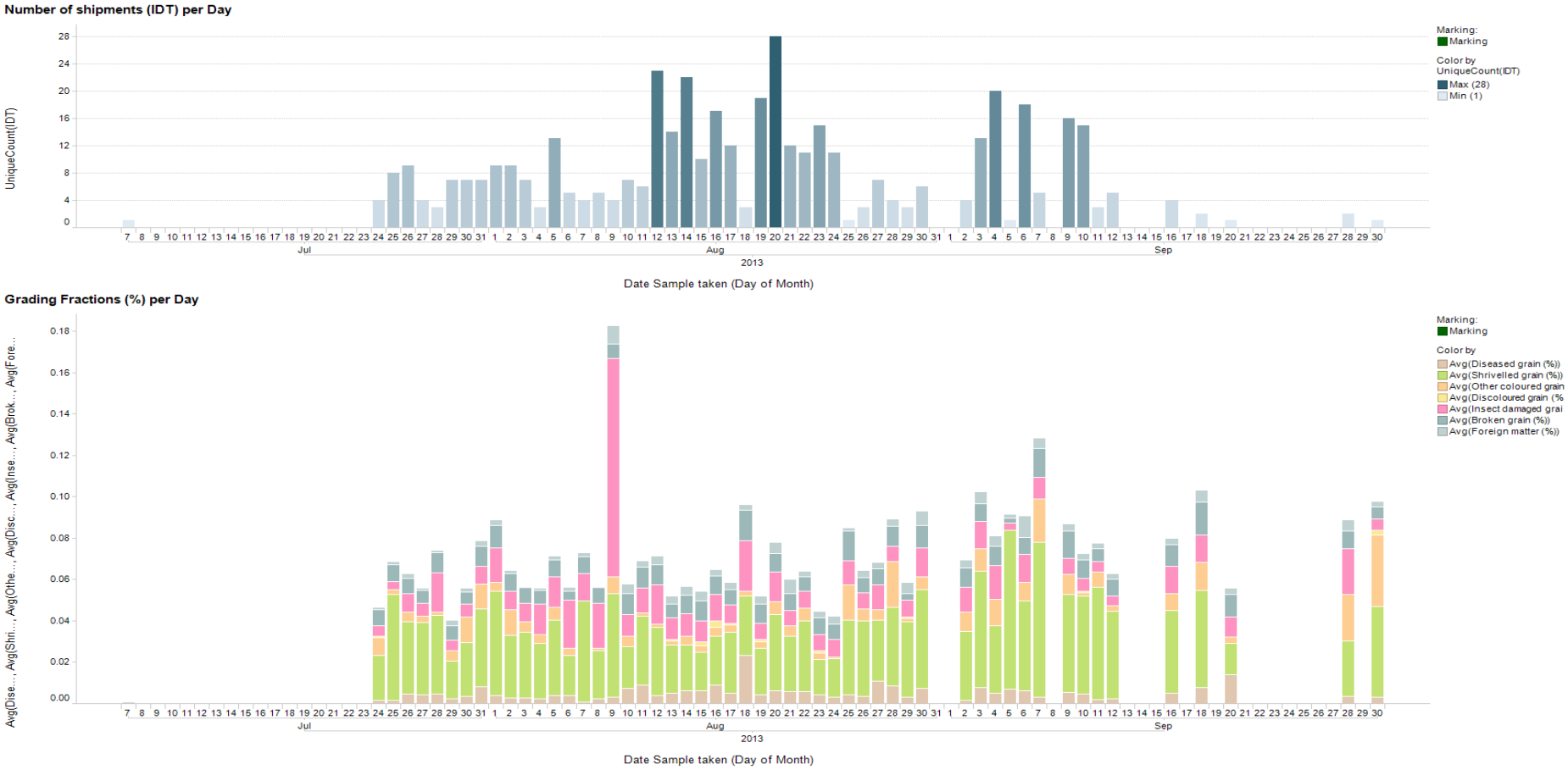
And the Katete District Agricultural Coordinator:

> "*There was transparency, the rule of first come first served was observed; there was adherence to quality standards for purchases. Farmers' payments have improved slightly, like I said the farmers that delivered first are the ones that are paid first. We don't expect to hear any quality complaints this season. There were people to ensure that quality checks are done, such that at Katete Central some maize was rejected*."
>
> "*The Pilot was a success, I would like to see something similar implemented in other districts. We can safely say that good quality maize was bought this year. Malpractice was reduced.* "

Appendix 2 – Detailed Results from Grading

By Bruno Tran

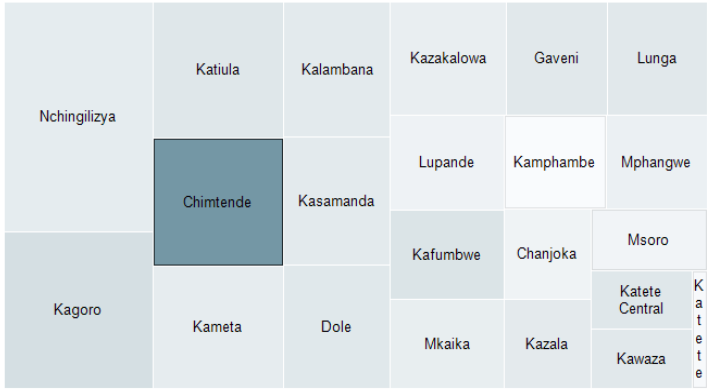
Timeline for the district:[12]



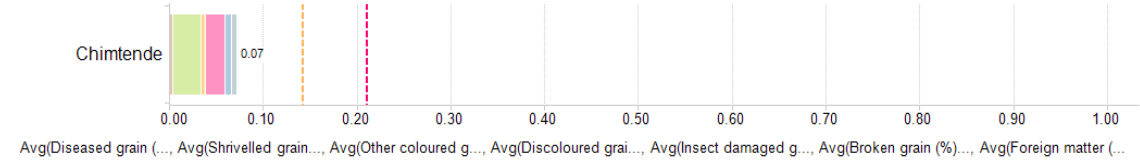
[12] Note the uncharacteristically large proportion of 'Insect damaged grain' delivered on August 9th. This consignment was identified as old grain that an unscrupulous trader attempted to sell as the new harvest. This is a perfect example of how bad grain can enter the system, and how proper checks can prevent this.

Overview by SCP:

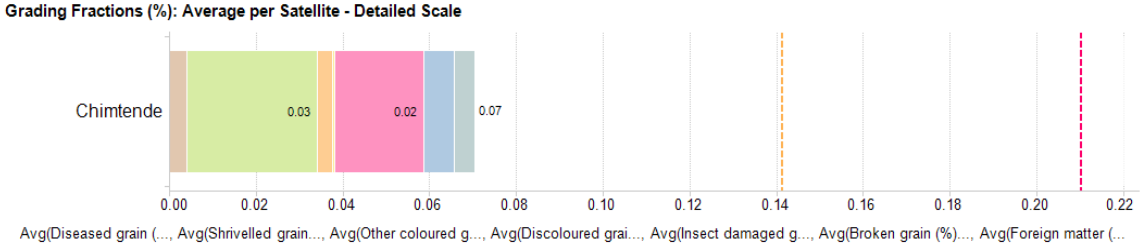
Number of trucks sampled per Satellite - Select Satellite to display detailed quality below



Grading Fractions (%): Average per Satellite - Full Scale



Grading Fractions (%): Average per Satellite - Detailed Scale



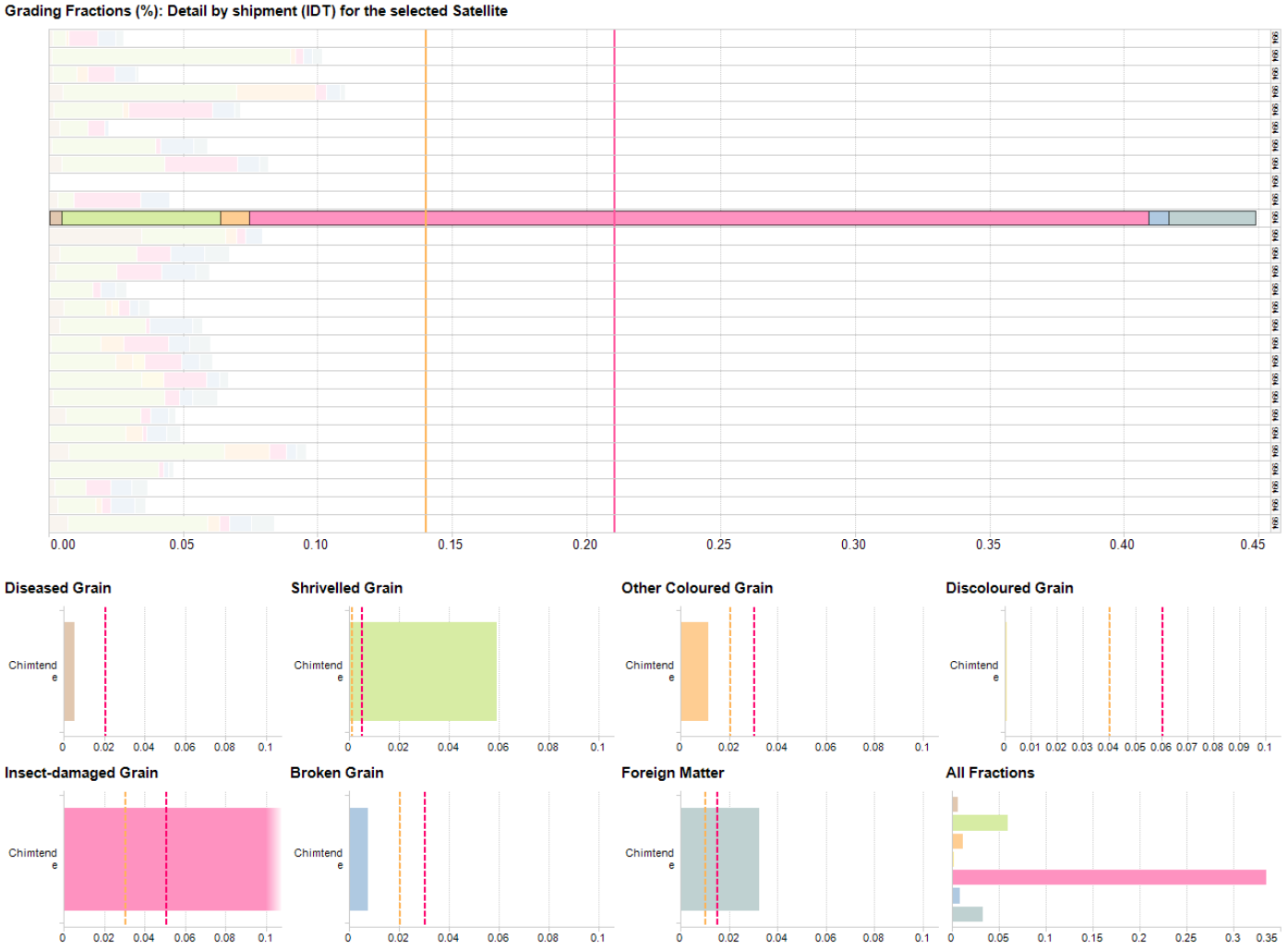
Grading Fractions (%): Detail by shipment (IDT) for the selected Satellite

Average percentages per SCP:

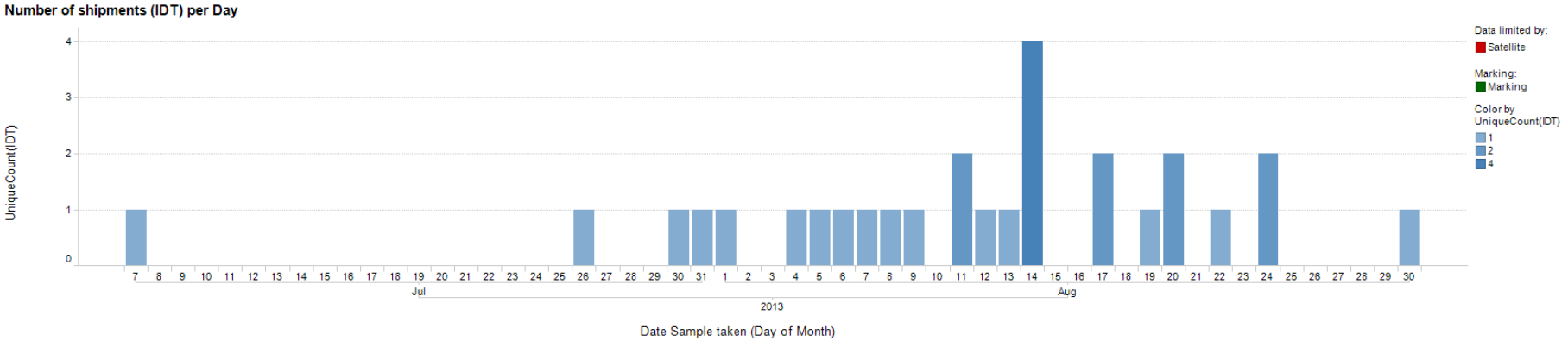
Percentages per shipment:

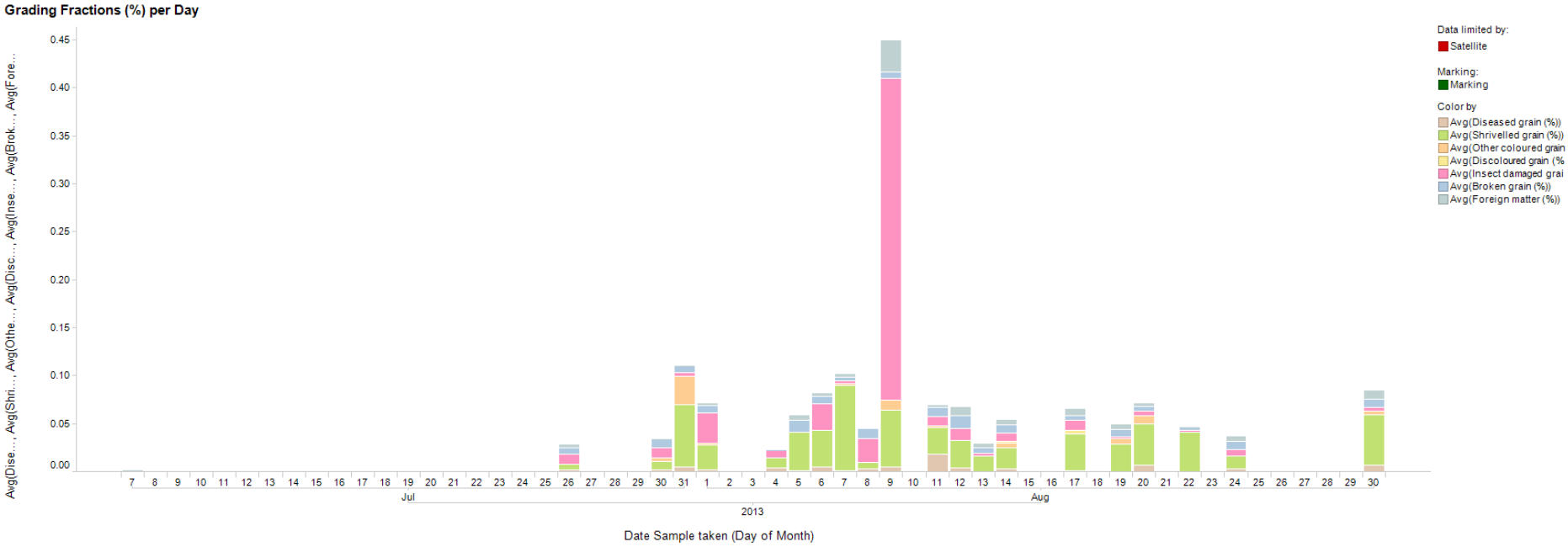
Select an IDT:

Satellite	IDT	A1	B
Chimtende	994304	0.03	- - -
	994305	0.10	- - -
	994309	0.03	- - -
	994310	0.11	- - -
	994313	0.07	- - -
	994314	0.02	- - -
	994317	0.06	- - -
	994318	0.08	- - -
	994319	0.00	- - -
	994321	0.04	- - -
	994322	- - -	0.45
	994324	0.08	- - -
	994325	0.07	- - -
	994326	0.06	- - -
	994328	0.03	- - -
	994329	0.04	- - -
	994330	0.06	- - -
	994331	0.06	- - -
	994332	0.06	- - -
	994334	0.07	- - -
	994336	0.06	- - -
	994337	0.05	- - -
	994338	0.05	- - -
	994339	0.10	- - -
	994341	0.05	- - -
	994342	0.04	- - -
	994343	0.04	- - -
	994344	0.08	- - -



Timeline by SCP:





Appendix 3 - Food Reserve Agencies: Factors Affecting Operational Structures & Management

By Tanya Stathers

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A: Brief History of Food Reserves

Throughout history food stocks have played crucial food security roles at national, community and household levels. The existence of the Chinese 'constant-normal-granaries' are documented since 498AD (Murphy, 2009). The bible recounts Joseph interpreting the Egyptian Pharaoh's dream of the seven fat cows followed by the seven thin cows as a requirement for the country to store a fifth of the grain produced during the seven years of plenty as a food stock for use in the seven years of famine (Genesis, 39-47).

Political agreement regarding an international food stock has not been achieved, and after the food crisis and prolonged drought in the Sahel in the 1970s most countries in Sub-Saharan Africa (SSA) established their own national food reserves. Some countries developed separate strategic grain reserve programs (e.g. Ethiopia and Malawi) while other countries added a strategic reserve as an additional mandate to their marketing boards (e.g. Kenya and Zambia) (Rashid, 2011). However in the last 20 years governments all around the world have either abandoned or dramatically curtailed their reserves (Murphy, 2009; Sampson, 2012a). This was due to a variety of reasons including: the shift in economic thinking in the 1980s which suggested government intervention in markets should be kept to a minimum, and that the private sector was inherently better than the public sector and led to major structural adjustment programmes across SSA; the high expense of operating often inefficient national food reserves which in some cases actually exacerbated hunger; the confusion which arose where reserves were used to try and meet more than one policy objective (e.g. food security, market development, price stabilisation; foreign currency shortfall compensations; political interests); the diversity of social, political, geographical and economic contexts in which the reserve was expected to operate. But increasing food insecurity, climate change and population growth projections and the 2007/08 food crisis (highlighting the limitations of relying on a widely deregulated private sector to manage stocks to serve the public good) have brought food reserves strongly back onto the agendas of many African governments and their development partners. As they explore ways to develop stronger and more resilient local, regional and national food systems (Sampson, 2012b), food reserves are commonly also seen as emergency food stocks and sometimes as part of a strategy of boosting agricultural production by providing a guaranteed market (Sampson, 2012a). Studies show that the low points in stocks-to-use ratios tend to coincide with price spikes (Wiggins and Keats, 2012). Explaining why governments' are interested in building up sufficient levels of reserves to cushion against short-term shocks. There is a continuing debate between those advocating that the best route to price stabilization lies in further liberalisation of trade, and those who perceive that occasional but major market failures warrant maintaining the capacity of Government to intervene (Maunder, 2013).

This renewed interest has triggered several studies of national food reserves (NEPAD, 2004; Rashid, 2011, Rashid & Lemma, 2011; IATP, 2011; World Bank, 2012; Maunder, 2013; Ernst & Young, 2013) which have reviewed the objectives and operations of national food reserves in different countries, discussed their role as emergency food reserves versus market stabilisation tools, and linkages with different private sector and development partners. These studies highlight the problems which reduce the effectiveness of food reserve systems as well as the policy changes that have contributed to enhancing them in some countries. Mali's programme is viewed as one of the best examples of an integrated food reserve system and Ethiopia's Emergency Food Security Reserve Administration (EFSRA) as one of the best examples of an emergency food-security reserve system with increasing integration with

other food security activities (NEPAD, 2004). A recent review of opportunities for public private partnerships with strategic grain reserves (SGR) in Nigeria, Ghana, Uganda, Zambia and Mozambique suggested investment opportunities in the near-term were limited to infrastructure and particularly warehousing, with the high politicisation and lack of stability in SGR policy and practices making it difficult to identify feasible investments (Ernst and Young, 2013).

As regards the overall management of a reserve, the most recent publically available guidelines seem to be the 1997 Lynton-Evans' FAO-published document on *Managing the Reserve*, although more recent technical guidelines specifically focused on postharvest handling and storage such as WFP's *Training Manual for Improving Grain Postharvest Handling and Storage*, and Hodges and Stathers, 2012 are also relevant. The structure and operations of food reserves will differ given the varied and unique social, political, geographic and economic situations, roles and sizes of each of them which influence dietary choices, storage infrastructure, transport networks, regional and international market integration, etc.

There are however some key cross cutting issues and lessons which can be shared. This is important as maintaining a food reserve is expensive, requires strong technical capacities and can have negative effects on markets, private sector development and investment (Rashid, 2011). For example, in Zambia, the FRA has become the dominant buyer of smallholder maize. Simulations show that FRA activities stabilised market prices throughout the July 1996 to December 2008 period and raised mean prices between July 2003 and December 2008 by 17 to 19 percent (Mason and Myers, 2013). While the price raising effects of FRA policies have assisted surplus maize producers they adversely affected net buyers of maize in Zambia, namely urban consumers and the majority of rural poor.

The challenges include finding ways to institutionalise these programs while minimizing operational costs and negative impact on the markets and farmers' production incentives (Rashid, 2011). Below we discuss some of the key factors affecting the operations and management of food reserves, dividing them into two main groups: those factors which are typically political and will be most likely to be addressed through advocacy; and those factors which are more practical in nature which the food reserve agency has direct control and influence over.

B: External Factors – Policy and Advocacy

Clear & Well-Defined Objectives

Many food reserves have attempted to cover too many conflicting objectives; this has led to confusion, particularly regarding their role in market price stabilisation and in meeting emergency food needs (NEPAD, 2004). The objectives need to be clear and if there are multiple objectives the potential contradictions and conflicts of interest need to be discussed (see Box 1 below).

Unambiguous operational guidelines must be agreed and put in place, as well as the requisite authority and means to fulfil these objectives (Murphy, 2009).

Box 1: Conflicting Objectives

In Zambia, attempts to support smallholders and urban consumers simultaneously (even during two recent, consecutive bumper harvests) led to significant market distortions and large fiscal costs but had little impact on poverty (World Bank, 2012).

In 2010 and 2011, Zambia's Food Reserve Agency (FRA) bought the total maize surplus of about 2 million tons at import parity prices. Neither the FRA nor private traders could export to neighbouring Zimbabwe or the DRC because domestic maize prices were about US$100 above the export parity (World Bank 2012a). To make things worse, consumers only partially benefited from the bumper harvests. Local food prices remained high because the FRA was able to sell only a small portion of its stocks, mainly through direct sales to several large mills that were slow to reduce maize prices for consumers. In February 2012, the FRA still had about 1.3 million tons of stock and was unable to find buyers, while domestic prices remained well above export parity. The overall outcome was little impact, at large cost, on the 60 percent of the population in Zambia that still live below the poverty line.

Political Aspects: Political interference in food reserve management can be very damaging – especially where food stocks are used to meet political objectives with no arrangements for stock replenishment (NEPAD, 2004). Given the high proportion of most SSA households' budgets which is spent on food, avoidance of any political interference in decision-making will be difficult, but systems need to exist to make it manageable and transparent. Lack of a consistent food reserve/ stock holding policy particularly with regards to replenishment and release procedures and pricing structures have been problematic in many countries (NEPAD, 2004).

The International Finance Corporation (IFC) recently funded a study to understand the operating environment for private sector agri-businesses with respect to SGRs in ten African countries (Nigeria, Ghana, Senegal, Burundi, South Sudan, Uganda, Rwanda, Malawi, Mozambique and Zambia). Overall they found that due to the highly politicised nature of SGRs and the high likelihood that government positions would change over time affecting SGR policy and practice, it was therefore difficult to identify specific investments which might be feasible in the short to medium term (Ernst & Young, 2013). Investment opportunities and the potential for Public-Private Partnerships (PPPs) in the short to medium term seemed limited to infrastructure, particularly warehousing.

Policy Environment: A food security policy which explains farmers, governments, private sector and NGO roles and planned activities regarding domestic food production, food trade and food reserves (for food emergencies and for safety-net programmes for the chronically food-insecure) for maintaining adequate food supplies is important. This food security policy also needs to be compatible with other key policies such as market development, agricultural productivity, and trade.

Coordination/Integration with Other Food Security Activities: Other food security system actors (e.g. NGOs, donors, civil society) should be involved in the Strategic Grain Reserve (SGR) in a decision-making capacity through its technical or steering committees (Rashid, 2011). Integration of the food reserve's activities with other food security and safety net programmes will help in rotating stock and therefore maintaining the quality of the stock, reducing costs and potential negative impacts on the market.

In Ethiopia, the efficiency of stock rotation and the associated cost reductions have been high primarily because most of the food-based intervention programs in the country are well-coordinated with the country's Emergency Food Security Reserve Administration (EFSRA) (Rashid and Lemma, 2011). A clear food security policy which encourages the participation

of key food system stakeholders (e.g. local traders, financial institutions and community-based organisation) and recognises the complementary roles of agricultural production, food reserves, safety nets and markets, will help ensure this.

Resources need to be set aside for effective communication campaigns.

Social safety net programmes and the coordination of food security activities: Social safety net programs are gaining popularity in many countries in SSA and can be an effective way of providing food access to the poor and helping them find more sustainable livelihoods. There are numerous arguments as to whether these transfers should be in-kind (mainly food) or cash (Coate 1989; Dreze and Sen 1990; Basu 1996; Gentilini, 2007; Alderman, 2011; World Bank, 2012). Cash-based transfers are generally thought to have two main benefits over food transfers. First, they are less costly to distribute than physical commodities, and second, household welfare is increased via greater flexibility in allocating resources (i.e. consumer sovereignty) (World Bank, 2012). Additionally they can increasingly be distributed electronically.

A review of 71 safety net projects supported by the World Bank found that projects supporting in-kind transfers, including food transfers, were among the lowest performing program type (World Bank, 2012). Food-based transfers are typically recommended in areas facing severe market failure, particularly under circumstances of food price inflation and severe food shortages (Alderman, 2011; Sabates-Wheeler and Devereux, 2010), or if the objective is to improve the nutrition (particularly if the food stocks are bio-fortified) and health status of a target group (World Bank, 2012). Safety nets and emergency programmes in many countries continue to be food-based due to low market efficiency, as they are commonly more politically acceptable, and/or because some donors may wish to support their own domestic farmers and shippers by using in-kind transfers (Rashid, 2011).

Recent case studies by IFPRI suggest that across SSA there is still a large unmet demand for school feeding programmes (Rashid, 2011; Rashid and Lemma, 2011), which could improve future human capital as well as productivity growth and market development.

Safety net programmes aim to meet the chronic food needs of poor and vulnerable populations, as opposed to emergency induced food shortages. However, the emergency reserve food stocks can be rotated through safety-net programmes. This can help to ensure the quality of the emergency food stocks, decrease the operational costs of the reserve and reduce market disturbances which can occur if stocks are rotated by just releasing them into the open market. The collaboration between Ethiopia's Emergency Food Security Reserve Administration (EFSRA) and NGOs has enabled it to more efficiently manage its food stocks, which are rotated through their use in the Protective Safety Net Programme (PSNP) and other food security activities. EFSRA's programme saw the number of people in need of food assistance decrease significantly as the PSNP started to cover a portion of the food-insecure population (Rashid and Lemma, 2011).

Interaction with the Private Sector

In many countries private firms of various sizes play important roles in the grain trade. An effective grain reserve needs to work with the private sector while protecting its public policy space. This is often not a simple task. One economist explained the risks "Although commercial stocks are somewhat higher when reserve stock programmes are not in effect, the private sector, farm and non-farm, has no incentive to hold socially-optimal levels of stocks" (cited in Murphy, 2009).

To enhance the predictability of public stock management and its successful coexistence with private storage and trade, resources need to be allocated for communication (World Bank, 2012).

A recent International Finance Corporation (IFC) funded study into the capacity to develop and implement PPPs with African SGRs found limited capacity to develop Public-Private Partnerships (PPPs) projects in Zambia. While in Ghana the Ministry of Finance has estimate that Ghana needs US$1.5 billion investment in infrastructure annually and intends to use PPPs as a way of achieving that investment. In Uganda there was an issue surrounding the need to convince small farmers to use well-managed warehouses which would affect any PPP investment in warehousing. Both Nigeria and Mozambique are also keen to have PPPs in their storage programme (Ernst & Young, 2013a).

C: Internal Factors – Management and Structure

Organisational Structure and Management

In countries where strategic reserves have worked well, such as Ethiopia and Mali, there was a conscious attempt to keep organisational structure thin, simple and flexible so as to be able to respond to emergency needs (Rashid, 2011). In less successful examples management structures have been too complex with overlapping and sometimes contradictory policy priorities and objectives (NEPAD, 2004).

Operational Guidelines: Clear operational guidelines for stock management are required (Rashid, 2011). There is no need to build bureaucracy around technical decisions. Clear and transparent triggers for releases should be documented and used to avoid market disruptions and politicisation of stock management (World Bank, 2012). Any change to operational procedures should be publicly announced in a timely manner to allow the private sector to adjust accordingly (World Bank, 2012). New technologies may offer operational efficiency gains. While clear operational guidelines are important, flexibility is also important in order to respond to emergencies and evolve as circumstances change. This requires procedures that are relatively simple and quick.

Operational Independence: It is recommended that emergency reserves are kept separate and independent from marketing boards and buffer stocks, and that clear operational guidelines exist regarding their use, release, management and rotation (Rashid, 2011). Some financial independence (such as a protected budgetary allocation) is viewed as desirable (Murphy, 2009). In many countries, sufficient financial resources to cover the operational costs have been lacking. However it needs to be recognised that the operational and opportunity costs of operating grain reserves are not small. In some countries spending on food stocks can exceed spending on agricultural research and other agricultural programs (see Table 1) (World Bank, 2012).

Table 1. Public spending on stock has often been larger than on agriculture and research

Country	Spending on public stock programs (% of GDP)	Spending on agriculture (% of GDP excluding [A])	Spending on agricultural research and development (R&D) (% of GDP)
	[A]	[B]	[C]
India	1% (2004/05) to 1.5% (2008/09)	1.2% (2008/09)	0.06% (2008/09)
Indonesia	0.5% (2008-10)	0.8% (2008)	0.05% (2003)
Philippines	0.4% (2005/06) to 1% (2009)	0.8% (2005)	0.06% (2002)
Zambia	0.3% (2009) to 1.9% (2011)	0.6% (2010)	0.15% (2010)

Source: Taken from World Bank (2012). Data on public expenditure on public stocks [A] for India are from Rhee (2011), Dawe et al., (2011), and government statistics; for Indonesiafrom Rhee (2011); for the Philippines from the World Bank (2007) and Rhee (2011); and for Zambia from IMF and Nkonde et al., (2011). Spending on agriculture [B] is from World Bank country reports and government statistics. Spending on agricultural research and development [C] is from Pardey et al., (2006) and World Bank country reports.

Staffing: Well trained and paid, committed people are needed to oversee and operate the food reserve (plan and manage the stocks and infrastructure including keeping accurate records of stock movement), and to coordinate its operations with the rest of the food distribution system. Adequate training is vital and an incentive structure will be required to retain them and ensure a high standard of performance (World Bank, 2012). Unfortunately corrupt practice has been common in some reserves (Murphy, 2009).

If the movement and rotation of the stock in the reserve is low, then staff productivity will also be inherently low, and labour costs per tonne handled will be high. Contracting out the grain storage can help reduce these costs, although additional staff costs will then be required to inspect and monitor the stock (Lynton-Evans, 1997). Increased rotation of stock will improve staff productivity. However, managing stock rotation and total volume are serious challenges for most food reserves. Some suggest the open market manages stock rotation much better, but usually disregards the costs of environmental pollution, destruction of natural resources and the food and nutrition security of the poor – all of which are government concerns (Murphy, 2012a).

Stock Size, Costs, Composition, Rotation, Location and Prices

Size: A clear process for determining the appropriate levels of stock for each region and season is required (Rashid, 2011). Traditionally the target size of a food reserve was determined on the basis of the cereal requirements of the vulnerable population for the time required following the recognition of an imminent food emergency until additional supplies could be made available for distribution, i.e. the "lead time" (Lynton-Evans, 1997). It was typically assumed that the cereal requirement was equivalent to some 160-175 kg per person per year and that a lead time of three months would be required to organise and receive additional supplies. The resultant size for the reserve was held static at this level until circumstances were considered to have changed and the calculation was repeated. This was usually only after several years. Countries which adopted this approach included: Ethiopia

(with an initial reserve size of 180,000 metric tons (mt) in 1982), Mozambique (60,000 mt), and Tanzania (100,000 mt).

As an alternative some countries based the size of their reserve on market demand, for example during the 1980's Zambia determined the target size for its reserve at an estimated three months' market demand (between 180,000 and 225,000 mt). This compared to reserves in Kenya of 270,000 mt, Malawi of 180,000 mt and Zimbabwe of 936,000 mt, who decided on their reserve using a variety of assessments (Lynton-Evans, 1997). However, calculation methods aside, few countries actually managed to meet their targets, with the notable exception of Malawi. Yet despite having met its target amounts, during the period from 1981 to 1996 Malawi only used its stock for emergencies twice (Lynton-Evans, 1997), underscoring again the high costs of maintaining stocks that are not necessarily going to be used each year. Similarly Switzerland has rarely used its food reserves for emergency purposes; however the system they use ensures the government does not cover the storage and rotation costs (see Box 2).

In Ethiopia, the size of SGR stock is currently based on the assumptions that (a) it takes four months to import and deliver food to the households needing assistance and (b) 90 percent of the vulnerable population needs to be provided with food for four months at 400 grams per capita per day (Rashid, 2011).

Box 2. Food stock management in Switzerland

Switzerland is one of the world's richest countries, and a net agro-food importer as it is only 48 percent self-sufficient in food plant products. As a result the country keeps food stockpiles, with the government deciding what quantities of each food commodity should be kept in stock. This is typically 3-4 months of consumption requirements for the whole population (7.8 million people), for sugar, rice, edible oils and fats, coffee and cereals. The Government inspects the stocks periodically, guarantees credits, and authorises market releases in case of any unusual trade supply disruptions. The last time Switzerland had to release emergency stocks was during the 1973 oil crisis.

All food importers are organised into a stock management organisation called 'Réservesuisse' which owns the stock and is responsible for the warehouse construction, food storage and rotation. The costs are fully financed by an import levy, making food security in Switzerland efficient and cheap, and paid for by the consumer not the state. However there are calls for the removal of this import levy which some view as circumventing the supposedly quota-free and duty-free market access for products from the poorest countries.

Sources: Haberli, 2013; Jarrett and Moeser, 2013, Egger, 2010

The above methods used for determining the size of reserve stocks assumed that the consumption pattern of the affected population would remain constant. However, in times of food shortage people change their eating habits, by switching to alternative foods, e.g. cassava and other root crops instead of maize, or, in the extreme, by eating less thereby reducing the demand for the staple food. In hindsight, many reserves are thought to have overestimated their emergency grain needs (NEPAD, 2004; Murphy, 2009). Efficient stock amounts, based on well-informed annual needs assessment, help minimize management costs and storage losses, and reduce the market price and production suppression effects of stock rotation activities (NEPAD, 2004). Current thinking suggests physical grain reserves should be kept to a minimum, and many suggest that food reserves should have both a grain and a cash component. At the time of the NEPAD (2004) study, Mozambique did not maintain a food reserve due to its good ports and well-functioning markets, however they are now developing food reserves and the government is beginning to construct silos which will be managed by the private sector (Ernst & Young, 2013a). Senegal kept a financial reserve instead of a physical reserve due to the high costs of maintaining physical food stocks and its easy access to international markets, it carried forward the budget allocation (financial

reserve) if it was not drawn upon (NEPAD, 2004). However total reserve stocks in developing countries as a group grew from 228 million tons in 2006/07 to 328 million tons in 2010/11 (up by 42 percent) and are projected to increase further to 343 million tons in 2011/12 (up by 51 percent compared to 2006/07), according to the US Department of Agriculture (Maunder, 2013). Reserves are a logical response to fears about the reliability of international markets. The political costs of unpreparedness or inaction are too high to bear for states where food still represents a major share of households' budget (Maunder, 2013).

The keeping of physical reserves is more crucial in areas where local markets do not function well and where there are long-lead times required to mobilise imports and food aid in the event of an emergency. However with climate change projections suggesting that extreme climatic events such as droughts and floods will increase in frequency (Intergovernmental Panel on Climate Change (IPCC), 2007), there will be an increase in the need for easy access to physical food reserves.

Maunder (2013) points out that there has been little critical examination of whether the assumptions used to justify the establishment of emergency reserves are valid. Are emergency reserves necessary to bridge until other resources come on stream? In the absence of reserves is there a substantial delay in mobilizing food resources for emergency transfers – or do other mechanisms fill this gap?

Costs: A World Bank 2012 study analysed the relationship between the size and storage duration of the stocks and their fiscal costs. The annual costs of storing and handling one ton of cereals range from US$21 in Egypt and Bangladesh, US$33 in Ethiopia, and US$42 to US$44 in Tunisia, Qatar, and Indonesia, to US$49 in Malawi and US$75 in Zambia (Cummings et al. 2006; Rashid and Lemma 2011; Rohrbach et al. 2010; Shepherd 2011; World Bank and FAO 2012).[13]

In Malawi, a comparison of the operational costs of holding different levels of stocks showed that doubling reserves from their actual level of 60,000 tons would have increased operational costs by more than four times during 1988 to 2008, due to the need to carry over stock during years of surplus production and the high economic costs of rotation (Faruqee, 2009). The longer stocks are kept, the larger the fiscal costs. In Malawi and Zambia, maize stocks are often kept for more than a year without rotation. Larger stockholdings can help reduce price volatility but often only to a point, after which increasing the reserve size does little. An overview of the food reserve costs in Zambia for 2011/2012 is provided in Box 3. Some stakeholders, including the World Bank, argue that the scale of the operational costs of food reserves has major opportunity costs, and that investment should be re-oriented towards increasing agricultural production and the resilience of agricultural production to shocks (Maunder, 2013).

[13] These costs do not necessarily include the same expenses in all countries, which may include handling, storage, fumigation, insurance, labour costs, and opportunity costs of tight capital.

Box 3: Fiscal costs of managing maize stocks in Zambia

A breakdown of the food reserve costs in Zambia, revealed that storage costs accounted for only 18 percent of total fiscal bill in 2011/2012 (Table 2) (World Bank, 2012). The most important cost element was a food subsidy to finance the difference between high prices paid to farmers and low prices for urban consumers (although it is millers who typically benefit from these low prices, and these benefits are not always passed on to the consumers). Transport costs for moving procured maize to silos cost 16 percent of the bill, while financing costs and bagging and re-bagging costs added another 18 percent.

Overall in 2011/12, stockholding operations in Zambia were estimated to account for 8 percent of the total national budget and 1.9 percent of GDP, without accounting for physical and quality losses. This amount equalled total road investments in the country and was much higher than Zambia's public spending on rural electrification, water, sanitation, and social programmes combined (World Bank 2012a).

Table 2. A breakdown of the total fiscal costs of managing maize stocks in Zambia in 2011/2012

COST ELEMENTS	US$ MILLION	PERCENT (%) OF TOTAL
Storage costs	63.0	17.9
Financing costs	38.0	10.8
Transportation of procured maize	55.0	15.6
Bagging and re-bagging	25.1	7.1
Food subsidy (release price – procurement price)	150.0	42.5
Construction of hard standing slabs	15.0	4.3
Rehabilitation of grain silos	6.7	1.9
TOTAL COSTS	**352.8**	**100.0**
Total costs as a share of total budget expenditure	8.2%	
Total costs as a share of GDP	1.9%	

Source: World Bank (2012a)

However, in spite of large budget resources being spent on price stabilization, the domestic cereal price volatility in some African countries including Kenya, Malawi and Zambia exceeds that of the international market and that observed in many neighbouring countries without buffer stocks (World Bank, 2012). In Zambia where procurement prices have recently been kept above the import parity level in spite of bumper harvests in 2010 and 2011, private sector activity has essentially stopped, as it is unable to compete with the FRA (World Bank, 2012a). This reduces the role of the private sector in efficiently moving goods from surplus to deficit areas. A recent study suggests that the Marketing Act, currently under ministerial review, would substantially limit the role of the FRA in the economy, providing what the private sector hopes is more certainty and less government intervention into the local maize market (Ernst & Young, 2013a).

Evidence indicates that in general reserves tend to increase average prices (McCreary, 2011). In Kenya the National Cereals and Produce Board is estimated to have raised average price levels by roughly 20 percent between 1995 and 2004 (Jayne et al., 2008). Zambia's Food Reserve Agency's (FRA) is estimated to have raised mean maize producer prices by 17 percent and consumer prices by 19 percent between 1996 and 2008 (Mason and Myers, 2011). By increasing producer prices, and often consumer prices too, this effectively results in a transfer from consumers to producers. Given that the majority of the food insecure – including small-scale farmers - are net food purchasers, this constitutes a regressive food security policy (Maunder, 2013).

Composition: Ideally the composition of foods in the reserve should reflect consumer preferences, including other non-maize staples which are normally readily available in the domestic market, and preferably locally produced.

In practice most food reserves just contain maize or wheat, as this makes stock management and budgeting operations simpler. However, this is viewed as having led to the increased dominance of maize in some agro-ecological areas that are not well suited to maize, as farmers view the reserve as a ready market. While maize production in these areas may result in surpluses for farmers to sell in some years, it has also led to increased crop failures as it becomes more dominant in the farming systems due to maize being less drought-tolerant than traditional crops and thereby exacerbating food insecurity in these locations (Lynton-Evans, 1997).

Rotation: Stock rotation is a difficult activity for food reserves to manage: if old stocks are not carefully released into the market it can cause market destabilisation and reduced private sector activity. However, effective collaboration with NGOs has enabled the Ethiopian EFSRA to cost-efficiently manage its stock. While many countries hold food stocks for more than a year, and 33 percent of Kenyan stock was held for longer than 9 months (Rashid & Lemma, 2011), by contrast in EFSRA 62 percent of stock had been there for less than 3 months in 2007-08 (however, this does not imply that these stocks were all freshly harvested grain as the time taken to source and ship it would need to be added) (World Bank, 2012).

At the average monthly storage costs of US$2.7 per ton, reducing the storage period of food stocks from 6 down to 3 months implied a 70 percent cost-saving (or about US$1,100,000) for EFSRA in 2005/06, (World Bank, 2012) and also reduces the likelihood of stock's deterioration during storage. EFSRA is the sole food stock in Ethiopia and all development partners borrow and replace grain from it for their project needs which increases the stock turnover rate.

A key distinction between EFSRA and the reserves of many other countries is that EFSRA does not engage itself with buying, selling, transporting, and distribution of grain. Instead, the agency serves as the custodian of the stock, built through donor and government contributions. The main responsibility of EFSRA is to manage the lending and replenishment of stock according to its operational guideline. All transactions have to follow strict procedures set by the EFSRA executive board (Rashid and Lemma, 2011). This lack of involvement in the buying and selling of the stocks is viewed as a key factor in the efficiency of EFSRA's operations.

The grain stored in food reserves needs to be regularly rotated otherwise its quality can deteriorate and then pose health hazards to those who receive this grain. The cost of fumigation and other pest control measures also increase the longer the grain is stored. Poor management of storage infrastructure has also resulted in high losses of stored grain (NEPAD, 2004).

Some public policy officials and many academics, argue that a cash reserve that allows a government to buy food when it needs it from world markets is more efficient than holding physical stocks (which are expensive to purchase and store, and which are perishable) (Murphy, 2009). Others believe a physical reserve offers an important strategy to ensure access to the preferred food type and to meet an unexpected spike in demand without the risk of not having enough foreign currency to make a purchase on the world market. Others believe that it may be psychologically reassuring to know that food is there should it be needed in a crisis, while cash reserves provide a more virtual and less reliable insurance, especially if there has been a history of problems regarding financial accountability.

If the reserve is involved in purchasing grain, then replenishments should be made through open tenders when prices are low, in locations close to strategic storage facilities by using existing market participants in their normal marketing roles (World Bank, 2012). While purchasing directly from farmers is attractive, mechanisms need to be arranged for it to be practical. When necessary, sales of stocks should also be made transparently through public open tenders at market prices.

Rotation strategies need to consider the timing of the grain rotation, not only with regards to its storage duration but also the timing of rotation within the crop cycle/season. Particular care will need to be taken when rotating grain towards the end of the marketing season when market supplies are running low and by which point in time there should also be a good indication of the crop prospects for the following year, and the reserves that are likely to be needed (World Bank, 2012).

Location: The reserve has to be held in locations where suitable facilities with adequate capacity for long-term storage of grain exist. Locating storage facilities in producing areas may save on transportation costs, as costs will only be incurred when grain is actually required in a particular location (Lynton-Evans, 1997). Quick access to markets and targeted beneficiaries needs to be factored into the decision. Positioning reserves close to the potential consumers (if this can be predicted in advance) can have benefits in terms of stock rotation arrangements and emergency response times.

While there could be advantages to spreading the reserve over several locations particularly where poorly functioning markets inhibit the emergence of resilient and reliable food production and distribution mechanisms (Murphy, 2009), consideration also has to be given to the ability to maintain control over and supervise the physical stocks (Lynton-Evans, 1997). The more fragmented the reserve becomes, the higher the cost of monitoring the integrity of the stock and the greater the likely need for subsequent stock movements. Historically marketing policies have tended to focus on meeting the needs of the urban consumer, leading to many storage facilities being located within easy reach of the main urban areas. A government might wish to locate a reserve in a remote or disadvantaged area to provide support to local producers, any additional operational costs incurred as a result could then be charged to the government as a social charge (Lynton-Evans, 1997).

Prices: If a price band is set it should be around the export and import parity prices in a way that smooths out occasional price spikes through market interventions that only occur every few years (World Bank, 2012). These interventions should not seek to flatten inter-seasonal fluctuations. This will reduce inter-annual price instability but leave season cycles largely unaffected, permitting the private sector to participate profitably in storage and trade.

A recent study reported a disconnect between Zambian maize prices and world maize prices, with maize prices on the South African Futures Exchange (SAFEX) of US$170 per mt in November 2008, compared with Zambian maize price of US$300 per mt until the 2009 harvest season (Ernst & Young, 2013a).

Access to Analytical Capacity and Utilisation of Information

Most food emergencies in the Sahel and Sub-Saharan Africa (SSA) are due to droughts, which if correctly identified early on can at least provide several months of planning time to source alternative food supplies and estimate quantities needed to make up the shortfall (Lynton-Evans, 1997; NEPAD, 2004; Murphy, 2009). Sharing of accurate and timely information can help avoid the need to store unused stocks, and allow regular adjustments to

stock quantities depending on updated needs assessments. Although individual countries' need for food aid varies significantly year to year, regional demand is much more constant (Murphy, 2009).

Access to crop production, climate, market prices and intelligence (including estimates of import needs, export potential, international prices, etc.), early warning system, vulnerability assessments and available stocks information is essential to enable a food reserve to plan, coordinate and implement its activities efficiently and meaningfully. Existing information systems have not provided reliable data on production prospects, stocks, consumption requirements and market conditions resulting in decisions based on inadequate data (Lynton-Evans, 1997; NEPAD, 2004). Whilst governments have been unwilling to make the investments required, it should be remembered that accurate information systems and decisions can help governments avoid the high costs of excessive reserve sizes or unexpected food emergencies (Lynton-Evans, 1997). Modern ICTs have a crucial role to play in integrating these information systems and improving the efficiency of stock keeping, storage, information sharing, and buying and selling helping make reserves more responsive to changing conditions. In addition to preparing these information systems, it is also useful to conduct a retrospective review of the past season or years situation and to openly discuss in what ways the data supplied was accurate or inaccurate and could be improved.

While no specific review of information systems of different food reserves was available, the Mali food security reserve system is recognised for its integrated nature as a model system. Key elements include an early-warning system, a market information system, a national security stock of between 30,000 mt and 35,000 mt, an emergency intervention unit, a joint counterpart fund, and a food-security fund (NEPAD, 2004). It is additionally recognised for its coordination between government and development partners, and the flexibility with which the coordination functions are carried out.

Infrastructure

Suitably located and well maintained transport, storage and communications infrastructures are required for efficient food reserves. The relevance of the condition of various infrastructures to the functioning of national food reserves is highlighted in Box 4 for Tanzania. In Zambia, FRA buys maize from multiple small-scale farmers. In 2010 it operated in 68 out of the 72 districts with the holding depots managed by co-operatives and farmer associations with approximately 10 satellite collection points (SCPs) per district. SCPs per district has since increased to about 15, resulting in more than 1,000 SCPs across Zambia, many in relatively inaccessible locations.

In a recent study funded by the International Finance Corporation (IFC) to understand the operating environment for private sector agri-businesses with respect to SGRs in ten African countries (Nigeria, Ghana, Senegal, Burundi, South Sudan, Uganda, Rwanda, Malawi, Mozambique and Zambia), investment opportunities and the potential for PPPs in the short to medium term seemed limited to infrastructure, particularly warehousing. Their study suggested that in some places there was an absence or insufficient capacity of warehousing while in others the existing warehousing was of very poor quality as well as being poorly managed (Ernst & Young, 2013).

Box 4: Relevance of infrastructure to the Tanzania national food reserves operations

Tanzania's main maize producing regions are the southern highlands and northern zones, from where it is easier to trade with neighbouring countries than to supply the traditionally food-deficit Tanzanian central zone. In keeping with its socialist policies warehouses (also known as 'godowns') were constructed throughout Tanzania in the 1970s, 90 percent of these are still in existence and some are leased to traders during crop harvesting seasons.

Following the serious 1972-1974 drought when cereal imports and food aid were used to supplement domestic supply, Tanzania established a strategic grain reserve (SGR) with the objective of reducing reliance on food imports in emergencies. Following market liberalisation in the mid to late 1980's, the SGRs main function became that of holding stocks for targeted interventions of the government rather than supporting a price-stabilisation policy. Although it still influenced prices as it was mandated to enter the market to purchase maize at an officially determined price and to sell its stocks at subsidised prices to target beneficiaries in food-insecure parts of the country. It was also meant to facilitate transfers of maize from surplus-producing to deficit regions at times when such transfers were not attractive to the private sector.

The SGR was managed by the Food Security Department in the Ministry of Agriculture, with major decisions being made by a Board of Trustees composed of high-level representatives from other ministries. Replenishments and releases were done through tendering: procurement was mainly from farmers and occasionally through imports. The reserve experimented with selling substantial quantities of grain to private traders at favourable prices with the intention that the traders would resell it in designated locations at an agreed low price. However, the traders did not respect their price commitments; and a more successful approach involved distributing grain to local authorities for sale to vulnerable groups at a subsidised price.

From the mid-1980s to mid-1990s, with the help of technical assistance Tanzania established a Crop Monitoring and Early Warning System and a Disaster Management Department, and developed a policy to guide implementation of SGR activities. However staffing and funding problems and lack of coordination with other government information gathering units have hampered the functioning of these information systems since. Despite the lack of credible food-security information, Tanzania has generated estimates of emergency relief needs based on direct assessments in typically food-deficit districts and these have provided the basis for decision-making on releases from the SGR.

In 2000, a Food Security Information Team was established comprising Government agencies (the Disaster Management Department in the Prime Minister's Office, the Food Security Department of the Ministry of Agriculture and Food Security, the National Bureau of Statistics, the Tanzania Food and Nutrition Centre, the Tanzania Meteorological Agency and the Regional Coordination Department of the Office of Regional Administration and Local Government), international organisations (FAO, UNICEF, WFP, USAID, the EU, and DFID) and NGOs (CARITAS, Oxfam-UK, Save the Children UK, the Norwegian People's Aid, and the University of Dar es Salaam's Rural Food Security Team.

In 2008, the SGR became the National Food Reserve Agency (NFRA), its objectives remained to procure maize from farmers or small traders, to store the procured maize, and to distribute maize to vulnerable individuals (mainly in rural as opposed to urban areas), institutions or other areas as instructed by government. The NFRA has seven zonal offices which are strategically located in surplus and deficit areas. Each zone is equipped with several grain storage facilities, NFRA has a total storage capacity of 241,000 MT within its 30 storage facilities, it plans to lease out those stores which are idle. NFRA purchases maize mainly and a little sorghum.

NFRA procures food stocks from July to December. Producers take their produce to a buying centre and if it meets the minimum quality requirements it is purchased at a pre-determined price based on the prevailing market price and unit cost of production. The number of buying centres is limited to prevent discouragement of the private sector. The grain is then taken to the storage facilities, where it is inspected, cleaned, bagged, stacked and stored. Quality control staff inspect it during storage. The Food Security Department in collaboration with the Local Government Authorities determines when food releases are required.

Poor roads and storage problems act as a disincentive for farmers to produce for the local market. Logistical difficulties combined with the often much higher food prices in neighbouring countries can create instability in Tanzanian food markets although the country usually has sufficient food available. The communal warehousing policy of the socialist era left a poor legacy, and most farmers prefer private storage.

The NFRA's website explains that it is currently installing heavy duty weighbridges in all its zonal offices, and that it has staff who are competent in the fumigation of warehouses, rodent control and food crop storage. It is planning to install grain driers in the high humidity Arusha, Makambako and Kipawa areas, to help dry their

The study also reported that the Zambian Development Agency, (ZDA) with the support of government, has been leading a programme to rehabilitate and upgrade some of the existing storage facilities, and to engage investment from the private sector to procure and build new storage capacity (Commodity Storage & Handling of Grains in Zambia, January 2012 cited in Ernst & Young, 2013a).

Relevance of Trade Impediments and Facilitators

Poor transport infrastructure and arbitrary national restrictions on food commodity trade can result in surpluses accruing close to areas with serious deficits. Intra-regional trade is also hindered by inadequate information and financial capacity among local traders and banks, and the absence of quality controls and standards (NEPAD, 2004). Well-targeted reserves can offer a real alternative to export bans. Reserves can be used to protect the poor while allowing price signals to be transmitted to producers. In contrast, export bans and other trade restrictions are a blunt subsidy to consumers, both poor and rich, at the expense of many poor farmers (World Bank, 2012). Farmers forego the opportunity to benefit from higher output prices when export restrictions are put in place, which in turn slows their supply response. Small reserves targeted to the poor are a much better solution in times of crises.

On-Farm Food Production and Storage

Capacity building of farmers and their service providers (public and private extension) in postharvest handling and management needs to go together with improved agricultural practices (e.g. diversifying cropping patterns, use of drought and pest tolerant varieties, water and soil conservation, farmer organisation and market information and linkages), and food security activities in order to help households (and therefore the nation) improve their food and nutritional security and the quality and value of the grain they can sell into the food system.

Regional Coordination of Food Reserves

The NEPAD (2004) review advised against setting up a regional physical grain reserve, due to the limited success and heavy bureaucracy of other regional initiatives. Instead they suggested food reserve coordination committees should be set up to facilitate the use of national reserves to serve regional objectives when necessary.

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Appendix 4 – Monitoring and Evaluation Findings for the Mobile-Technology Solution

Mobile-Technology (M-Tech) Monitoring and Evaluation (M&E) Plan

An M&E plan was developed before the start of the pilot project and refined during the early stages of implementation.

Function and Objectives

The M&E of the pilot has two functions: firstly to monitor the system in order to provide support and rectify problems with the system, and secondly, to evaluate the following two key objectives of the pilot:

1. Establish the effectiveness of the mobile data collection platform used at the satellite collection points (SCPs) in entering and transmitting data to the district offices on a daily basis.
2. Determine how the platform can be up-scaled to be used in all districts.

Activities

Three tools were used for collecting data:

- Weekly questionnaires sent to the satellite depots
- System log books where any issues or changes of the system are recorded (the questionnaire and the format of the logbook are found in the appendix).
- Interviews with users and stakeholders affected by the pilot

Categories

The M&E plan was divided into the following three categories:

1. Hardware, Software Design and Support to the System
2. Data Quality and Effectiveness of the System
3. System Adoption and Evidence for Scale-Up

For each of the three categories the M&E plan looked at the following outcomes:

1. Hardware, Software Design and Support to the System
    - Outcome – All users on the system are able to connect to the internet
    - Outcome – The equipment at the SCP is and remains in good working condition
    - Outcome: All users were effectively trained to use the platform

2. Data Quality and Effectiveness of the System
    - Outcome – The solution captures and presents data in the required format
    - Outcome – The solution captures data accurately
    - Outcome – The solution captures data in a timely manner
    - Outcome – The system performs with minimum support requirements

3. System Adoption and Evidence for Scale-Up

- Outcome – The system is adopted at district-level to capture maize purchase data
- Outcome – The users adopted the system to capture transport data
- Outcome – Quality feedback on the system is received and effective
- Outcome – The design and implementation of the system permits scaling-up
- Outcome – The benefits of the system are enumerated

For each of the listed outcomes the monitoring and evaluation will look at key indicators.

Results

Category 1 - Hardware, Software Design and Support to the System

The results for each of the outcomes were as follows:

Outcome 1: All users are able to connect to the internet

Results: Internet connectivity was a challenge in about 50 percent of the satellite depots.

- Three SCPs were given Airtel SIM cards because of poor MTN network coverage in their area.
- The average data usage for the SCPs was 250MB.
- The data bundles of 500MB provided to the SCPs was more than enough to send the data.

Conclusions:

i. Before the implementation of a mobile solution network connectivity for SCPs must be determined.
ii. Users should be blocked from using the Android tablets for personal use.

Outcome 2: The equipment at the satellite depot remained in good working condition and can be used for project purposes

Results: Equipment failure Rate:

- Android Tablets: zero failure rate
- Solar: Failure rate was 23 percent. Of the chargers that did not completely fail 40 percent did not charge the solar battery properly.

Rate equipment missing:

- Android Tablets: three chargers went missing
- Solar: No chargers went missing

Keyboard/screen used for data entry percentage:

- 61 percent of SCPs used the touch screen to enter the data, the rest used the keyboard.

Conclusions:

i. The selection of high quality Android tablets, the Samsung Tab, and the use of the protective covers resulted in none of the tablets being broken or damaged.
ii. It is suspected that the high failure rate of the solar product was due to the use of lead acid batteries for the solar battery pack. Lithium ion or suitable alkaline batteries are recommended.
iii. The power specifications of the solar equipment were correct. The solar equipment that worked was able to charge the tablets during normal sunny weather.

Outcome 3: All users were trained effectively to use the platform

Results:

- 64 percent of the SCP buyers performed well, 5 percent did very badly and the rest were poor.
- A comparison of training results with the performance in the field shows that some of the very good performers during the test did not manage to use the system properly and some bad performers managed to use the system very well.

Conclusion:

i. These training results do not reflect how well people can perform in the field.

ii. Performance in the field is determined mainly by interest.

Category 2 - Data Quality and Effectiveness of the System

The section looks at four outcomes and their respective results:

Outcome 1: The solution captures and presents data in the required format
Results:

- The dashboard captures all the data when correctly submitted by the SCPs, however it was unable to generate three reports requested at provincial level:
  - Daily maize purchase report (also called national maize purchase report)
  - Weekly crop status reports
  - Weekly stock ledger reports
- The transport monitoring system was able to capture the data correctly, however it was unable to generate the reports requested by the province in the required format.

Conclusion:

i. Further development of solutions needs to be done in close collaboration with the relevant provincial officials/authorities in order to ensure the system has the correct specifications.

Outcome 2: The solution captures data accurately
Results:

- The data entry error rate by the SCPs was found to be about 25 percent.
- Errors were mainly incorrect spelling of names and incorrect NRC numbers.

Conclusions:

i. The data provided by the SCP's contains a high percentage of errors.
ii. The district should always verify the data in order to identify and rectify errors.

Outcome 3: The solution captures data in a timely manner
Results:

- Daily data entry rate depends on many factors, including:
  - User commitment
  - Failure of solar chargers
  - Overcast weather conditions
  - Poor support from ISP who did not activate bundles or SIM cards
  - Poor Network in certain areas

- Lack of involvement by District staff to urge SCP's to submit data on time.

Conclusions: In order to have data submitted on time by the SCPs the above factors must be attended to.

Outcome 4: The system performs with minimum support requirements

Results:

- The support required for the system is very high. Reasons for this can be categorised as follows:
  i. Equipment
     - High failure rate of the chargers
     - High data usage of some of the SCPs, running out of data bundles.
     - Poor performance and support by the mobile phone operator MTN.
  ii. System design
     - Blocked Google accounts needed to be re-activated
     - New files were over written by old versions of the files
     - Links between files were corrupted
     - Problems on the Android tablets could only be rectified at the district
  iii. Human factors
     - Non-submission of data by SCP staff at the beginning of the pilot
     - Failure of SCP staff to report issues
     - SCP staff tampered with Android tablet settings, uninstalled the software and changed network settings.
     - Challenges in getting the correct data entered into the system
     - District main depot staff would take the internet connection home and exhaust the bundles.

  However the main reason for the high levels of support required was district staff did not operate the system, and the support team ended up operating the system.

Conclusions: The mobile data collection system required a high level of support which can be addressed by attending to the listed issues.

Category 3 - System adoption and evidence for scale-up

Outcome 1: The system is adopted at the district to capture maize purchase data

Results:

- There was partial adoption of the system to capture maize purchase data: Summum support staff operated the system and FRA staff made use of the data to report to provincial level.
- The system was used for farmer payments (i.e. sending the lists of farmers to be paid to district and provincial levels). However the data entered by the SCPs was not verified.

Outcome 2: The users adopted the system to capture transport data

Results:

- The system is being used to collect transport data at the end of the pilot. During the first three weeks of the pilot the system was still in development. When the system became operational it did not contain any data and required FRA staff to update the entire system. Summum support staff did this. Only when the system was updated did the district staff start using the system.

Outcome 3: Quality feedback on the system is received and effective
Results:

- The quality feedback came into operation in the second month of the pilot.
- SCP staff were not trained in looking at this data many did not make use of it.

Outcome 4: The design and implementation of the system permits up-scaling
Results:

- *Organisational issues* may affect the system's up-scaling. These include:
  - Operational procedures for various situations are unclear (e.g. when transporters exceed their loading order quantities or deliver less bags than on the order
  - SCPs and depots are not provided with adequate tools to do their work (e.g. ICT hardware, internet connectivity, furniture)
  - Recruitment of the SCP staff is done just before the start of the buying season, not allowing enough time to do the training.
  - District staff appeared unsure of their duties and responsibilities.
  - Record keeping and filing was poor.

- *Staff issues* may affect the system's up-scaling. These include:
  (For SCP staff)
  - Motivation of staff to submit data
  - Passiveness in reporting issues
  - Failure by satellite depot staff to bring in weekly summary returns

  (For district staff)
  - Lack of computer skills
  - Failure to adopt the new system
  - Lack of commitment.

- *Technical issues* with the *Dashboard* and *Transport Monitoring* systems may affect up-scaling:
  - *Dashboard* - The current use of the excel application and the cloud service does not allow for a reliable transfer of data between the different users. The reasons for this are:
    - There is no control over the Gmail accounts, accounts were randomly locked
    - The Planmaker software loses the link between files when the file is not saved and closed properly.
    - During synchronization there were cases of randomly created duplicate files. This caused the system to show incorrect data.
    - The setup of the individual user accounts using a cloud based storage platform with shared files is time consuming and difficult to manage
  - *Transport Monitoring:* The transport file is a complex Excel file that records the dispatch data. It enables one to see if trucks that left the SCP arrived at the district depot.
    - Despite password protecting the Excel files it is difficult to prevent users from changing formulas.
    - The files tend to become very big, making it difficult to send to the provincial level where this data is required

- Inter-Depot Transfer Notes (IDTs) can be cancelled. There is need to capture and collect cancelled IDTs so that they can be captured in the system.

Conclusions: On *Organisational Issues*: The above issues will affect up-scaling the system.
On *Technical Issues*: The current design of the system needs to be overhauled to guarantee minimum errors.
On *Staff Issues*: In order to scale up the system there is need to increase the training, set-up proper procedures for the users on how to use the system, and for supervision by related departments on all activities at district-level.

Outcome 5: Other benefits of the system (besides those already mentioned)
Results:

- The system is able to improve the performance of the FRA's staff.
- The system is able to track the performance of the SCPs. Daily monitoring of the submitted data enables tracking of SCPs' performance. One example that the system managed to highlight is that more maize was transported from the SCPs than purchased.
- The SCPs are using the Android tablets to communicate with the district staff, meaning communication between the SCPs and district is done increasingly by email.

Conclusions: The system is able to track the performance of the SCP staff but not the district staff.

Outcome: The system highlights previously unknown issues in the FRA's operations
Results:

- The system allows the auditors to immediately get all the required data, allowing for the audit to be completed in a shorter time
- The use of loading orders at the depot is chaotic and inconsistent.
- Loading orders, whereby the transporter transported more maize more than stated on the loading order, were compensated by allocating new loading orders and recording transport from the overrun loading order on the new loading order.

Conclusions: The system can improve the turnaround time of depots as all the data is readily available in a structured system.

Recommendations

The M-Tech component of the pilot was able to prove the concept that the use of Android tablets can improve data collection within FRA's operations. However the pilot also made it clear that there are numerous challenges in scaling this up.

As recommendations for the scale up we review below design, implementation, technical and staff issues.

Design
The system needs to address two areas:

- Data collection from the SCPs using the Android tablets and the display of this data in the correct format to the users
- Recording of the transport data at the district level. The system captures the data correctly, closely following the paper trail currently in place. The data collected is the

data required at the district and the province levels. However the data should be available at the head office and provincial-level as well as district-level.

When designing the system's specifications, solutions for the district, the province and head office should be clear in terms of:

- What is the data collected
- Who needs to see what data
- Who is responsible for the data entry and verification
- What are the reports required
- Who will enter the GRN and IDT forms
- What will be done in the system with incorrectly completed GRN and IDT forms

Implementation

When developing and implementing a system for the FRA it is absolutely necessary that the system is fully functional when the buying season starts. Otherwise it seriously disrupts FRA operations. There should be a period of at least 8 weeks before the buying season when the system is ready and can be tested in the field.

Technical issues

The system requires a centralised management structure in order to allow the scale up of the platform. This requires that the system has a central database that can be accessed through the internet.

Organisational issues

In order to run a mobile data collection system there is need for clear responsibilities and procedures at the district level. Another requirement is the improvement of the IT infrastructure at district level to archive and file data.

Staff issues

There is a need for thorough training of the SCP staff. The main depot staff must have basic computer skills and should be responsible for checking if SCPs are sending data.

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