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Pre-evaluation of a soil and plant laboratory in Mozambique

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Mission report

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Abstract

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Mozambique is a country with great agricultural potential. Soil and plant tissue lab services are important to support this development and there is a growing demand for these services. This report describes the results of a mission to Mozambique in order to investigate 1) Present and future demand of lab services by commercial and small farmers, 2) Task, services and future location, 3) Economic analysis of the laboratory, 4) Interested parties and possibility of a Public Private Partnership. Finally a stepwise approach is described in order to develop a sustainable soil lab in Mozambique.

Keywords: Soil laboratory, agriculture, Mozambique, sustainable.

This report describes the results of a mission in Mozambique on request of the Embassy of the Kingdom of the Netherlands in Maputo, Mozambique

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Mission report

Wageningen, November 2012

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Summary

During a visit of Secretary of State Bleker to Mozambique in October 2011, the Mozambican Minister for Agriculture, Mr Pacheco, put forward a request for support to a soil and plant tissue laboratory in Mozambique. This laboratory should respond to the growing demand for soil and plant tissue lab services. The desire is to locate the laboratory in Chimoio, a town in the Beira Corridor in the centre of Mozambique with great agricultural potential. On request of the Embassy of the Kingdom of the Netherlands in Maputo, Mozambique the authors of this report had a mission in Mozambique, in order to investigate the preconditions of such a laboratory to make it a success. Sustainability was the most important precondition.

The necessary information was collected by interviews with different stakeholders, including the Ministry of Agriculture, commercial and small farmers, research and educational institutes, commercial parties (fertilizer industry, laboratory sector and organizations promoting the development of the agricultural sector in Mozambique. An open mind set was essential in these interviews to find the most optimum solution.

The following subjects were the most important in the interviews and discussions 1) Present and future demand of lab services by commercial and small farmers, 2) Task, services and future location, 3) Economic analysis of the laboratory, 4) Interested parties and possibility of a Public Private Partnership.

A laboratory for soil fertility with a capacity of around 10,000 samples per year was considered to be the best first development to be stimulated. This is in line with the expected demand in the coming year and the scale is also in agreement with the experience of laboratory staff in Mozambique. To make it sustainable the lab has to be a private organization that has the service to farmers as first priority. Profit of the work has to be available for necessary supplies, maintenance of equipment and investments in instrumentation and new developments (e.g. plant tissue analysis. Direct connection to a research and educational institutes is not recommended, because these organizations have other first priorities.

IIAM has a special position in the development, because the staff in the IIAM laboratory has experience on soil analysis and will be able to train the future staff of the new soil laboratory. Further the IIAM laboratory can take the role as national reference laboratory. For organizations like ISPM and IAC we do not recommend a strong link, but these laboratories can profit from the new laboratory by having support on ordering supplies, maintenance of equipment and having the opportunity to send internships to the lab and visit the lab with their students.

A town like Chimoio is a proper place to build the laboratory, because this is attainable by customers and also by technicians giving service to the instrumentation.

Because a laboratory will not be profitable from the start it is recommended to set up a public private partnership to start the laboratory. BAGC is a proper organization to take the lead. Finally a stepwise approach is described in order to develop a sustainable soil lab in Mozambique. Starting with a PPP, the laboratory should develop into a private laboratory giving services to agriculture.

A soil analysis has to be accompanied by an advise on the use of fertilizer, manure and if necessary lime and compost. Large farmers will be able to do this by themselves, but small farmers will need an expert. It will be necessary to create an advisory sector that is able to advice the framers. The structure and financing of the advisory sector should be subject of discussion during the set-up of the laboratory.

1 Introduction

1.1 Reason and objectives

During a visit of Secretary of State Bleker to Mozambique in October 2011, the Mozambican Minister for Agriculture, Mr Pacheco, put forward a request for support to a soil and plant tissue laboratory in Mozambique. This laboratory should respond to the growing demand for soil and plant tissue lab services. The desire is to locate the laboratory in Chimoio, a town in the Beira Corridor in the centre of Mozambique with great agricultural potential (Figure 1).

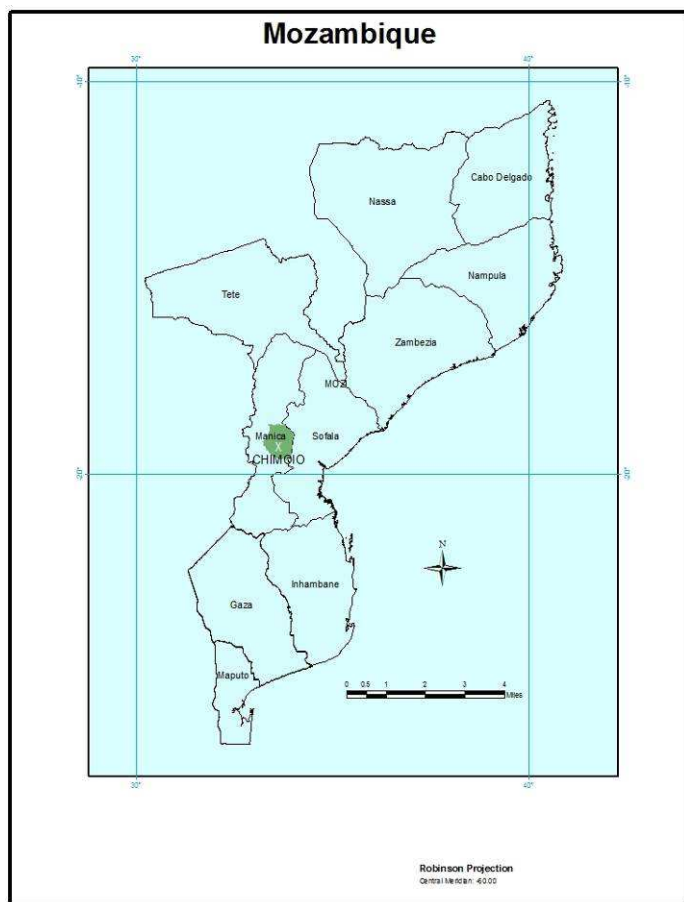


Figure 1. Map of Mozambique, with Chimoio in the centre

This request has resulted in a mission of the authors of this report to Mozambique in the period June 22 – July 7, 2012. In this report, our methods are justified and results are described.

Laboratories have been set-up before, also by the Netherlands, but the functionality of these laboratories on the moment can be questioned. The possibilities to do the proper analyses are drastically reduced and even absent by lack of funds to have the proper maintenance and to buy necessary reagents and tools. This in spite of efforts of the local staff. After a certain period it will be necessary to establish a complete new laboratory. This non-sustainable process is presented in figure 2.

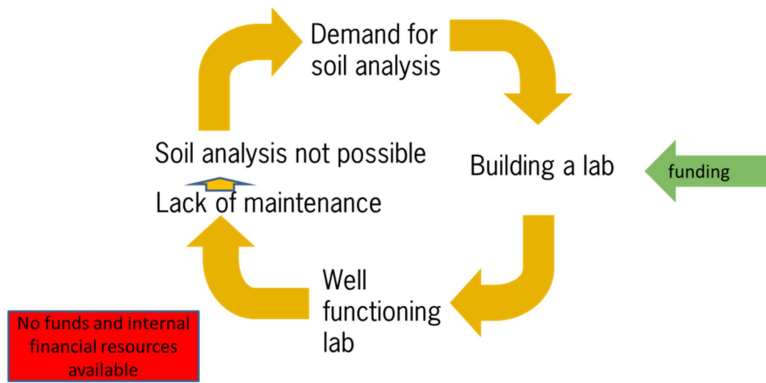


Figure 2. Non-sustainable establishment of a soil laboratory

To avoid a repetition, this mission was focussed on the sustainability of the new laboratory. Is the laboratory demand driven, can private investments be arranged, who will be the users of the new laboratory facility and are they able to supply the necessary funds for all actions (e.g. maintenance, supplies, building, salaries)? It will be important to find financial sources, not only for the start, but especially for maintenance (figure 3).

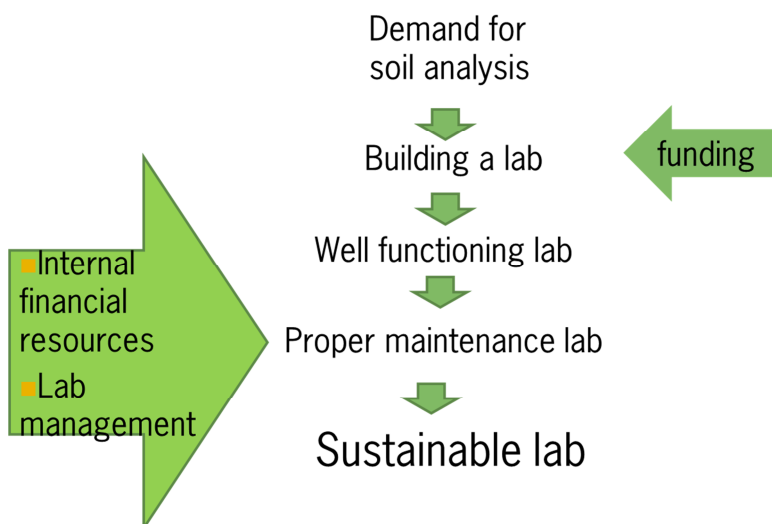


Figure 3. From demand for soil analysis to a sustainable laboratory

The objectives of this project are:

1. To assess the feasibility of a soil and plant tissue laboratory in the Beira Corridor in Mozambique
2. To develop a business plan how to realize the laboratory in a stepwise approach

A necessary condition is that the laboratory needs to be partly financed by private money at the start and fully by private money in the long run.

We have investigated

- The market, who will use the laboratory and who is able to pay.
- Which type of laboratory is needed
- Reliability (quality control) of data produced by the laboratory, and how to use the data
- Location of the laboratory
- The management model
- Sustainability
- Short and long-term activities

Results are obtained by interviewing stakeholders and discussing ideas. Starting with an open mind was essential and the results described in this report should be considered as results of a group process. All people involved are mentioned in the program of the mission described in chapter 2.

1.2 The context

Mozambique is an African country with a high economic performance, with an annual growth of more than 8% over the last two decades. However, this growth has not been realized in agriculture, but in other industries. Agriculture contributes for about 24% to the national economy and 16% to export. Mozambique is a net importer of agricultural products. About 80% of the working population is working in agriculture. This implies that only a small proportion (less than 25%) of the agricultural products is sold on the internal market or for export. The vast majority of the farmers are smallholders, only producing for their own family. It is estimated that the production level is 20% from the maximum level. Only a small proportion of the farmers are producing commercially. The consequence is that farmers don't profit from this growth. The availability of natural resources (gas, aluminium etc.) attracts huge investors from abroad, which want to exploit those resources. Land grabbing can be the consequence. Therefore, farmers run the risk to lose their means of existence, which will increase the social inequality and poverty.

In order to prevent farmers from losing access to means to generate income, the Mozambican government enhances the development of agriculture with an emphasis on:

1. Development of agribusiness
2. Sustainable use of natural resources
3. Applying research and development of agricultural production technologies
4. Infrastructure
5. Development of human capital

In this project we focussed on the Beira Corridor region. This region has been selected because it has a high agricultural potential. Several initiatives have been undertaken to support a shift towards commercial agriculture and the production of cash crops. Part of these initiatives is supported by Dutch development cooperation. An example is the Beira Agricultural Growth Corridor partnership (BACG), a public-private partnership (PPP) with the objective to contribute to the development of commercially-viable agricultural business and to provide an enabling environment for agricultural production. The development of a soil and plant tissue lab is one of the initiatives that fit's in this development framework. The Government of Mozambique will provide necessary protection of the proposed investment when implemented in the PPP mode."

2 Program of the mission

The program of the mission has been made by the Dutch Embassy in Maputo (see table 1. The members of the embassy (Jan Huesken, Sergio Ussaca) were also involved in several meetings. Reports of the meetings are given in annex 1 to annex 11

Table 1. Program of the mission

| Day | Date | Hour | Activity | Report in annex |
|-----|--------------------|-----------|--|-----------------|
| 0 | 23/06 Saturday | TBD | Arrive in Maputo reception by EKN staff member Exchanging ideas with Jan Hueskens | |
| 1 | 24/06 Sunday | 10:00 | Mr. Randolph Fleming from Agrifuturo | 1 |
| 2 | 25/06 Monday | 9.00 | Team meeting to discuss assignment objectives and anticipated impacts, as well as the work itinerary, logistics of the assignment and read documentation | |
| | | 15.00 | Emersen Zhou, BAGC | 2 |
| 3 | 26/06 Tuesday | 7:45 | Briefing with EKN FN&S team | |
| | | 8:30 | Nurbibi Cossa and Suzie Aline from IIAM, | 3.1 |
| | | 10:00 | Visit IIAM soil and plant tissue labs, discuss with labs staff | 3.1 |
| | | 14:00 | Daniel Clemente, Permanent Secretary and Dr. Macamo, Adviser of the Minister of Agriculture,; | 3.2 |
| | | 15:00 | Dr. Maposse, General Director Institute of Agricultural Research of Mozambique, | 3.3 |
| 4 | 27/06 Wednesday | 8:00 | Dr. Antonieta, Director National Platform for Agrarian Research and Technologic Innovation PIAT /EMBRAPA/JICA, | 4.1 |
| | | 14:00 | Dr. Alexandre Director Swiss Lab and discuss with lab staff/management | 4.2 |
| | | 16:00 | Representatives OMNIA . | 4.3 |
| 5 | 28/06 Thursday | 8:30 | Customs authorities discuss rules and procedures for importing lab equipment; Followed by discussion with Filipe Guiamba (Customs clearance agent | 5.1 |
| | | 10:30 | Mr. Abdul Mussuale, General Director Center for Promotion of Commercial Agriculture, | 5.2 |
| | | 14:00 | BAGC representatives contacts in Manica; | 5.3 |
| | | 16:00 | Mr. Eric Schmidt, Country Director International Fertilizer Center (IFDC), | 5.4 |
| 6 | 29/06 Friday | 7:00-8:45 | Travel to Chimoio and check-in into Hotel | |
| | | 11:00 | dr. David Mariote, Eduardo Mulima and Miguel Magalhaes – Centro Zonale IIAM Chimoio | 6.1 |
| | | 14:00 | Dr. Rafael Massinga ISPM Director, receive briefing on development of soil and plant tissue lab under development; | 6.2 |
| | | 16:00 | IAC Director, receive briefing on development of soil and plant tissue lab under development; | 6.3 |

| | | | | |
|----|--------------------|---------|---|-----|
| 7 | 30/06 Saturday | 8:00 | Visit Vanduzi Company (Augusto Jaime) | 7.1 |
| | | 10.30 | Visit Phoenix Seeds (Mr. Kevin) | 7.2 |
| 9 | 02/07 Monday | Morning | Visit IIAM research station in Sussundenga; | 8.1 |
| | | 14:00 | Feedback meeting with the Beira Agricultural Growth Corridor stakeholders | 8.2 |
| 10 | 03/07 Tuesday | 8:00 | Dr. Amimo Provincial Director of Agriculture Manica; | 9.1 |
| | | | Return to Maputo, | |
| | | 13.00 | Dr. Rebbie Harawa, Regional Representative AGRA - SHP, (Teleconference using Skype) | 9.2 |
| 11 | 04/07 Wednesday | 9:00 | Validate findings with experts and resource persons; | 10 |
| 12 | 05/07 Thursday | 9.00 | De briefing with dr Maposse General Director IIAM and Dr. Macomo Advisor of the Minister of Agriculture. | |
| | | 11.00 | Dawie du Plessis, Country Manager Intertek | 11 |
| | | 15:00 | Debrief and present findings to EKN. Agree on last actions to be taken for validation of data and verification of proposed lab functionalities and business plan; | |
| 13 | 06/07 Friday | | Finishing concept report | |

3 Evaluation of interviews and discussion

In this chapter we describe different aspects that are important for the development of a sustainable laboratory in Mozambique.

3.1 Other laboratory initiatives

3.1.1 IIAM

Maputo

The National Agriculture Research Institute (IIAM) is a public organization under the Ministry of Agriculture (MoA). The mandate of IIAM is to provide technical, scientific, and administrative support to the MoA and other government institutions for developing and coordinating agrarian policies. The IIAM has four zonally research centres. Each research centre has the mandate for developing agrarian technology for areas of your mandate. The IIAM has several national and international partners working in different research program of IIAM such as livestock research, agronomy, soil and water, crop improvement, and technology transfer. Currently, interaction between agricultural research and farmers is limited. The PIAT initiative supported by the USAID intended to improve efficiency of agricultural research in Mozambique and contribute to technology transfer to smallholder farmers.

The soil laboratory of IIAM in Maputo has been equipped in the nineties of last century. Also the laboratory staff has been trained in that period. On this moment several laboratory instrumentations are not functional anymore, but still analysis can be done. The trained laboratory staff is still present (Figure 4). The best trained employees are close to retirement. The lab will be newly equipped and a training program is already started. The lab should be developed as a reference lab for soil analysis in Mozambique.



Figure 4. Well trained staff in IIAM laboratory in Maputo

Sussundenga

IIAM has a large (450 ha) zonal agricultural research centre in Sussundenga. The ministry of agriculture wants to strengthen this centre. Several field experiments are going on (figure 5). Soil samples, plant tissue samples

and water samples have to be investigated and therefor laboratory capacity is needed. There is already a basic laboratory present used for seed selection.

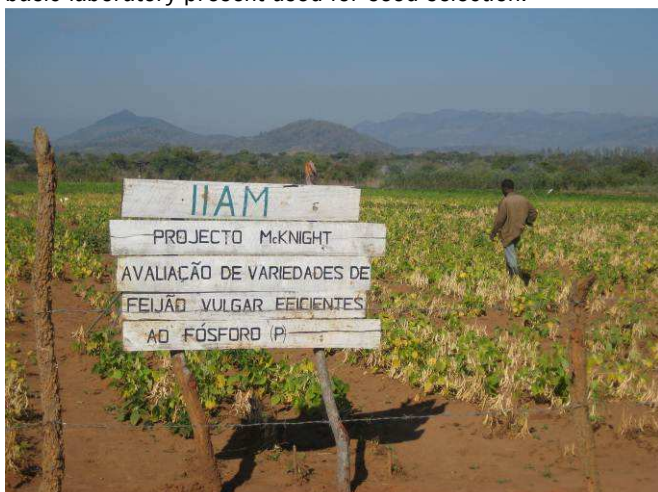


Figure 5. Field experiment on the agricultural center of Sussundenga

3.1.2 ISPM

ISPM - Instituto Superior Politécnico de Manica (Higher Polytechnic Institute of Manica) wants to enhance its institutional capacity to provide quality education in agriculture (BSc-level). A project to support this will be started in the NICHE program (Netherlands Initiative for Capacity development in Higher Education). On this moment activities concentrate on the building of a new campus near Chimoio. A new laboratory building is part of the campus (figure 6). Having a laboratory is important because students in Mozambique need more practical training



Figure 6. Building of a new laboratory on the campus of ISPM

USAID, represented by AgriFUTURO has made funds available for equipment (\$75.000). AgriFUTURO has asked Intertek to help with these equipment and also on management of the laboratory. It is suggested to use overcapacity of the lab for commercial purposes like soil analysis, seed germination and testing plant products on aflatoxin. The laboratory build is basic, but suitable for students. A fuming board was not planned, but will probably be added after our visit. Technical staff to manage the laboratory is not available yet.

3.1.3 IAC

IAC educates students on secondary level to become technical assistant. Also here the practical part of training has to be improved. A project of the Ministry of Education has made it possible to send equipment to IAC and this equipment is waiting to be installed (Figure 7). Only part of this equipment is suitable for soil analysis. Teachers receive questions on soil analysis and they have the idea to use the capacity to answer these questions and have some commercial activities. A laboratory staff is not present.



Figure 7. Laboratory equipment at IAC waiting to be unpacked and installed

3.2 Future customers

During our visit we have visited two large commercial farmers with a drive to develop analytical capacity, because they need it for their management. Vanduzi grows high value products (Figure 8) for export to the UK and send frequently soil samples (approx. 300/year) to a laboratory in South Africa, before Zimbabwe. They also contract smaller commercial farmers and have their soil also analysed. Phoenix Seeds samples less intensive and has approx. 25 samples analysed per year in Zimbabwe. Sending samples is a difficult procedure, because customs are involved. Both enterprises have found the way to send samples but this will be difficult and probably impossible for an individual small (commercial) farmer.



Figure 8. Growing of mini maize on an irrigated plot of Vanduzi

Both enterprises have a large social conscience. We do not know to what degree those commercial farmers are representative for other commercial farmers. On the contrary, if they are not, this does not imply that don't support the establishment of a private soil lab.

We also have visited a group of small farmers, organized in an association. They are supported by an extension worker. Fertilizers are used already and the irrigation system will be improved (figure 9). Crops are produced for the local market. Soil samples are not taken and analysed. The function of soil analysis is not known, also not by the extension worker. Advice on fertilizer use is based on generic advices.



Figure 9. Meeting with small farmers at an irrigated field

The agricultural area used by commercial farmer on this moment is approx. 3% of the total agricultural area. It is expected that the area used by commercial farming will grow in the coming years. We have not investigated this growth. Estimates for the year 2017 made in our interviews differ from a growth of 20% (pessimistic) to a growth of 60% (optimistic). We used a growth-scenario to 30% which means that the number of soil samples will increase with a factor 10 in the coming 5 years. We realize that this growth has to be supported by a lot of additional changes. There has to be a market for the product, which has to be developed including necessary infrastructure and institutions.

3.3 Functionality of the laboratory

Three different functions for the laboratory have been identified:

- Service laboratory to analyse soils in order to advice farmers about fertilizer use
- Research
- Education

It is important to distinguish the different functions and not to mix them up. The primary function of the lab to be developed is to analyse soils and to advice farmers. Research and education will be secondary tasks.

IIAM is a research institute. Research requires flexibility in the use of equipment. Soil analyses and developing advices for farmers is one of the research topics. Soil analyses are also needed for several research projects. On this moment IIAM can be considered as one of the large potential customers of a soil laboratory. However being responsible for a commercial soil laboratory is not the ambition of IIAM. The knowledge on soil analysis is present at IIAM and this knowledge has to be used in the development of the soil laboratory.

ISPM and IAC are educational centres and need laboratory facilities to teach their students. They have both been asked to do analysis for farmers. As long as this is in agreement with the curriculum of the centre and the planning of educational activities in the year, this might fit. A stream of hundred or more samples in a week will have a strong impact on the possibilities on education is not desirably. Furthermore, use of equipment by different students may cause deviations in the results. We therefore recommend that the soil laboratory should not be connected with an educational centre. Although we did not visit universities, this conclusion is also valid for universities.

Because a laboratory with primary task to analyse soil in order to advice farmers does not exist in Mozambique, such a service lab should be established.

3.4 Tasks and Services of different types of laboratories

3.4.1 Service laboratory

The following subjects (in order of importance) have been identified to be important for the agricultural sector:

1. Analysis to improve soil fertility and to increase the yields
 - Soil is considered to have first priority, because this will increase soil fertility all over the country and can be used by all farmers.
 - Plant tissue is important because based on this analysis a farmer can decide to supply specific nutrients to prevent deficiencies. This service will be used by more experienced farmers. It is necessary to have these analyses in the same laboratory to increase the value of the interpretation. The facilities as used for soil analysis can also be used for plant tissue analysis. It is only necessary to invest in possibilities for destruction of the material (solve the component of interest to be able to measure).
 - Improvement of seed quality is also important for increasing the yield. Therefore, testing seed on germination can be added, although this requires additional equipment.
2. Analysis related to food safety and environment.
 - In order to safeguard public health, the absence of aflatoxin is important and increase of demand on this type of analysis is expected. For this type of analysis other equipment is necessary and new investments will be necessary.
 - Food safety asks for analysis on phyto-toxicity, residual pesticides and presence of toxic components. The lab is not designed to do these analyses. It can be decided to include these services in future, but there are already other initiatives to do these analyses (Swiss Lab, Intertek). Especially for pesticides and other organic components complete new investments have to be made (chromatography including MS-detection. A microbiological lab will be necessary for phytotoxicity.
 - Environment. In a developing economy, environmental aspects will become more important. For these analysis the same is valid as mentioned for food safety

We recommend to concentrate on 1) Soil fertility with soil analysis as first priority, followed by plant tissue analysis. If there is demand for aflatoxine (first item in 2), this analysis can be added in the near future, but this means that extra investments (HPLC) and extra training will be necessary.

3.4.2 Laboratories for research

Laboratories for research are designed to give services to the projects of the research institute. The possibilities on a research lab may partly overlap with a commercial soil laboratory, but the research lab needs more flexibility. Sometimes parameters have to be added and for other research projects it will be sufficient to analyse only a few parameters. It can also be necessary to modify a method to be fitted for purpose defined

by the project. Several parameters will not be interesting for a commercial laboratory because of the small and temporary demand.

Of course it is possible for a research laboratory to do analysis for the market, but this can and will only be done temporary. As soon as capacity of the lab is necessary for own samples and other types of analysis, this will get preference.

Research laboratories have a special task in developing methods for new questions. After solving the question the method can be taken over by the service laboratory if this analysis will improve the quality of advices. In Mozambique the research laboratory of IIAM has a special function. It is identified that there is a good knowledge on soil and plant tissue analysis. This should be used in order to further develop the laboratory capacity of the country. It is therefore recommended to consider transfer of knowledge and training of staff for a new laboratory as a service of the IIAM laboratory.

3.4.3 Laboratories for education

We have experienced that several labs connected to educational centres do not only look to a laboratory to be used to educate students and to be used by students. They also think that after use by students the residual capacity can be used for commercial activities. Doing analysis for farmers is often proposed. In several cases donors are found to equip the lab. Unfortunately we have seen a lot of unpacked equipment with questionable usability for education. We do not recommend combining education and commercial activities for the following reasons:

- The quality of a student is unpredictable. Some are very good, but others will disrupt functioning of instrumentation and even damage them
- It is difficult and probably impossible to obtain an accreditation for a lab on which students are also working.
- If laboratory service becomes important there will not be enough possibilities for students to have training.

However, we think that having a laboratory is very important on an educational centre. It has to be equipped on such a way that students are able to work with it and will learn the basic principles of analytical chemistry related to soil and plant tissue. In the Text box two examples are described.

Examples of the use a laboratory for education

Fosfaat in soil

Fosfaat is important in agriculture. It can be analysed by extraction of a soil sample with water or water with specific salts. The result is used to advice on the use of fertilizer. The extraction is simple and can be done even without special glass ware. Shaking of a certain amount of soil (balance needed) with a certain amount of water (measuring cylinder or pipet). After filtration (funnel with filter paper) A certain amount is pipetted in a measuring flask and some reagents are added. A blue color is developed which can be measured with a simple spectrofotometer. The student also have to prepare samples with known concentration for a calibration curve.

Results can be used to prepare an advice for the use of fertilizers

Salinty

If too saline water is used in irrigation, the salt content in the soil may become too high to have a proper vegetation or the salt may destroy the soil structure. The salt content in water can be used with an Electro Conductivity (EC) meter. Students also have to check the functioning of the meter with a standard solution and measure the effect of temperature on the results. Measurements in soil extract are also possible

3.5 Advisory sector

Laboratory results on their own have no meaning for most customers. Experienced large commercial farmers are able to use the laboratory results directly for their own fertilizer management. For smaller commercial farmers it is necessary to translate the laboratory results in an advice for fertilizer management. It is therefore necessary that such an advisory system will be developed together with the development of the laboratory.

The role of an advice will be clear for commercial farmers and it is expected that these farmers are willing to pay for the combination soil analysis and advice. For small farmers more time will be needed and small farmers have even to be convinced that soil analysis and advice are profitable for them.

Having an advisory sector will be profitable for small farmers as can be explained by Figure 10. On the moment, small farmers produce about 20% of the potential yield. A lot of extra efforts are needed to reach 100% and this is not realistic on the short term. It is however possible to increase the production with only little extra effort. Advisors can play an important role by giving free advises to small farmers based on the experience and soil analysis of commercial farmers. Doubling the yield is a realistic scenario.

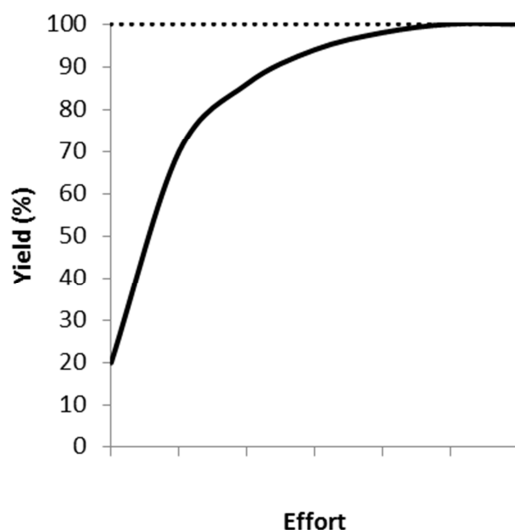


Figure 10. Relation between extra efforts and yield by small farmers

In a next step soil analysis can be involved and due to the success of first advice in combination with the results of commercial farmers, small farmers will make use and pay for the extra service. The advisory sector will also have an important function in marketing of the product of soil analysis followed by advice.

We do not have ready for use answers on how the advice sector has to be organized but also this organization has to be sustainable. A few possibilities are given below;

- Use the existing structure of extension, created by the government and NGO's.
- Look to possibilities to create a PPP to develop the advice task as identified in this report.
- Link the results of the laboratory directly to a computerized expert system. This model is used in soil laboratory in The Netherlands doing soil analysis for farmers. The customer receives a report on the soil analyses and an advice on the application of fertilizers and if necessary lime and compost.
- The fertilizer sector can also give input and the network of selling points can have a function in giving the proper advices on fertilizer use.

3.6 Development IIAM laboratories

IIAM is a research institute with a first priority to do soil analysis for own research projects. The laboratory has well trained employees, but is lacking reagent and tools and well-functioning equipment. The staff of the laboratory can play an important role in soil laboratory development in Mozambique.

The original lab has been established almost 20 years ago with support of The Netherlands and staff has been trained in Wageningen (The Netherlands). Only part of the equipment is still functioning. The laboratory will be newly equipped with support of Embrapa and the staff will be trained on the new equipment. Having the well trained staff on new equipment, this laboratory can be used to train the technicians of the new laboratory. We propose that as soon as it is decided to build a laboratory. The new technicians of the laboratory will go to Maputo for a training of several months and work together with the technicians of IIAM in Maputo.

IIAM should focus on the analysis for their own projects and further development of the different laboratories as a tool in research projects.

3.7 Accreditation and Certification

Certification and accreditation is asked on the moment by customers of laboratory results to assure a certain quality. Mozambique does not have an accredited lab on soil measurement. To be accredited a laboratory has to show that his quality is fit for purpose. The procedures in ISO17025 are leading for this purpose. An important issue is that the laboratory can show that his results are reliable and for this purpose participation sample exchange programs (e.g. WEPAL) is necessary. The laboratory has to build up history. It will need at least 2 years after starting analysis to build up a record and to be accredited

For the time being, it is important to realize that trust in the results is the most important part on the issue of quality. Accreditation is a formal procedure to guarantee that the laboratory is following his own procedure and that the quality of the data is as it can be expected. As long as accreditation is not possible, the PPP has to do things that assure that the results are reliable. Organizing audits are part of it and we expect that private partners in the PPP will be able to organize the audits.

4 Economic analysis

4.1 Lab infrastructure

In order to do an economic analysis, it is necessary to know which kind of laboratory is necessary and which kind of investments have to be done. We used as starting point the number of analysis. With respect to the necessary equipment for soil analysis options are:

- A small basic laboratory for approx. 500 samples/year
- A middle sized laboratory with a robust set of instruments for approx. 10,000 samples/year
- A large laboratory with an advanced set of instruments for more than 30,000 samples/year

4.1.1 Small laboratory, 500 samples

With a limited amount of samples it will be difficult to maintain a laboratory with expensive equipment. The costs of analysis will be very high. Results in such a laboratory can be based on commercial available test kits (Figure 11). Some of these kits are made for screening, it is only possible to distinguish between high and low and some can deliver more accurate analysis. Infrastructure can be a room with one table and possibilities to clean. The test kits are designed that a researcher is doing his own analysis.



Figure 11. Use of a test kit (Photo Hach-Dr Lange)

4.1.2 Middle sized laboratory, 10.000 samples

A laboratory on the scale of 10.000 samples per year will need more infrastructure and equipment. Infrastructure is necessary to receive samples, dry and grind the samples and to extract samples to make analysis possible. Equipment like Atomic Absorption Spectrophotometry (AAS) and Auto-analysers will be necessary (Figure 12). 10.000 samples/year or 50 samples a day can still be controlled with lists and data programs like Excel (e.g. two series of 25 samples).

We recommend to start with this middle sized laboratory with robust set of instruments because it covers all necessary analyses for fertilizer use, and it will be profitable with a lower volume of samples analysed as will be shown in 4.2. To operate such a lab, 5 skilled technicians are needed, supervised by a lab manager.



Figure 12. Atomic Absorption Spectrophotometer in use on the laboratory of IIAM (Maputo)

4.1.3 Large scale laboratory

If number of analysis is increasing, also the laboratory has to increase. The first increase can be forestalled by for instance doubling equipment. With a further increase (> 30.000/year) handling of the samples becomes difficult and the laboratory will need a Laboratory Information Management System (LIMS). Such a system makes use of barcodes and after reading the barcode the different instruments send the result to a central system which assures that the results of one individual sample come together in one final report.

Also regarding equipment other types of instruments will be necessary, for instance an Inductively Coupled Plasma (ICP) for the analysis of metals. Large sample treatment system will be part of the laboratory (Figure 13)

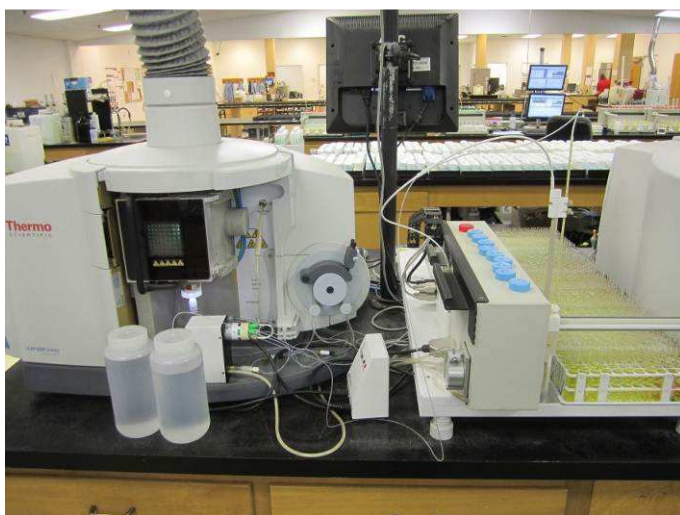


Figure 13. ICP for analysing K, Ca, Mg, Na, Zn, Fe, Mn, Cu in soil on a large soil laboratory in the USA

Although we expect that the number of samples in Mozambique will grow, we do not advice to invest in such a large laboratory and we prefer the middle size laboratory. If there are more than 30.000 samples a year a private investor will do the investments.

4.2 Economic evaluation.

4.2.1 Costs of a middle sized laboratory, 10.000 samples

In the project we have investigated the demand for soil analysis qualitatively. There seems to be a great demand, mainly from commercial farmers, but also from smallholders unified in a cooperative or a union. However we have not been able to investigate the current demand for soil sample analysis quantitatively. Therefore we have made some draft calculations to get a feeling about the number of samples to get a laboratory profitable, dependent on the price per sample, paid by the customer.

On behalf of the calculations, we have chosen the following principles:

1. The lab has the following characteristics:
 - a. A building of 250 m².
 - b. Equipment: Spectrophotometer, atomic adsorption (AAS), auto-analyser, flame photometer, other instruments
 - c. Staff: 6, 1 lab manager, 5 technicians.
2. Capacity is approx. 10,000 samples per year.
3. All costs are fixed except the costs for reagents.

The estimation of the costs (\$) are listed below, for building and equipment in table 2 and for staff in table 3. A distinction has been made between Investments, depreciation time of the investment, the percentage maintenance costs. The annual costs are calculated as Investment/depreciation time + investment * maintenance %.

Table 2. Costs for building and equipment

| | Investment (\$) | depreciation time (year) | maintenance (% of investment) | Annual costs (\$) |
|-------------------|--------------------|-----------------------------|----------------------------------|----------------------|
| Building | 300000 | 40 | 0 | 7500 |
| Equipment: | | | | |
| Spectrophotometer | 10000 | 10 | 10 | 2000 |
| Atomic adsorption | 30000 | 10 | 10 | 6000 |
| auto-analyzer | 65000 | 10 | 10 | 13000 |
| flame photometer | 12000 | 10 | 10 | 2400 |
| Other instruments | 10000 | 10 | 10 | 2000 |
| Furniture | 30000 | 10 | 0 | 3000 |
| Glassware | 75000 | 4 | | 18750 |

Table 3. Costs for staff

| Staff | Number | Yearly costs per staff member (\$) | Total (\$) |
|--------------------|--------|---------------------------------------|---------------|
| Lab manager | 1 | 14000 | 14000 |
| Technicians | 5 | 8500 | 42500 |
| Total | | | 56500 |

Reagents cost \$2 per sample. Unforeseen costs are estimated at \$ 20,000 per year.

Next the total revenues of the lab have been calculated as the number of samples multiplied by the price per sample. The number of samples varies between 0 and 10,000. The prices range from \$ 10 to \$ 35. Costs and revenues are presented in table 4.

Table 4. Total revenues and costs dependent on the number of samples and the price per sample.

| Number of samples | Total costs | Revenues at a price of: | | | | | |
|-------------------|-------------|-------------------------|--------|--------|--------|--------|--------|
| | | \$10 | \$15 | \$20 | \$25 | \$30 | \$35 |
| 0 | 131150 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1000 | 133150 | 10000 | 15000 | 20000 | 25000 | 30000 | 35000 |
| 2000 | 135150 | 20000 | 30000 | 40000 | 50000 | 60000 | 70000 |
| 3000 | 137150 | 30000 | 45000 | 60000 | 75000 | 90000 | 105000 |
| 4000 | 139150 | 40000 | 60000 | 80000 | 100000 | 120000 | 140000 |
| 5000 | 141150 | 50000 | 75000 | 100000 | 125000 | 150000 | 175000 |
| 6000 | 143150 | 60000 | 90000 | 120000 | 150000 | 180000 | 210000 |
| 7000 | 145150 | 70000 | 105000 | 140000 | 175000 | 210000 | 245000 |
| 8000 | 147150 | 80000 | 120000 | 160000 | 200000 | 240000 | 280000 |
| 9000 | 149150 | 90000 | 135000 | 180000 | 225000 | 270000 | 315000 |
| 10000 | 151150 | 100000 | 150000 | 200000 | 250000 | 300000 | 350000 |

The breakeven points (number of samples at which total costs equals total revenues) are presented in table 5.

Table 5. Breakeven points dependent on the price per sample (standard equipment)

| Price per sample | Number of samples |
|------------------|-------------------|
| \$10 | 16394 |
| \$15 | 10088 |
| \$20 | 7286 |
| \$25 | 5702 |
| \$30 | 4684 |
| \$35 | 3974 |

Investment in an ICP

The sample capacity can be expanded by replacing the atomic adsorption by an ICP. This requires an investment of \$150,000 instead of \$ 30,000. Furthermore, because Argon has to be used, the variable costs for the use of reagents increases from \$ 2 to \$ 3 per sample. The consequence is that the breakeven points increase (table 6).

Table 6 Breakeven points dependent on the price per sample (including ICP)

| Price per sample | Number of samples |
|------------------|-------------------|
| \$10 | 22164 |
| \$15 | 12929 |
| \$20 | 9126 |
| \$25 | 7052 |
| \$30 | 5746 |
| \$35 | 4848 |

Discussion

The calculations in this section are executed quick and dirty. In the first place the values are estimated by the authors without verifying external sources. In the second place some costs may be missing. One of the missing costs is rent about the invested capital. The authors lack information about the percentage which should be applied. This leads to an underestimation of the costs with at most a few per cent.

4.2.2 Price strategy

It is recommended to charge a competitive price from the beginning, both for commercial farmers and for smallholders. A competitive price is necessary to attract commercial farmers to shift from the current soil analysing laboratory abroad to the new laboratory. The direct advantage of shifting is no clearance costs, lower transport costs and shorter lead times. The disadvantage is that a starting lab needs to build up trust, which is important. It is therefore not recommended to impose additional barriers by asking a higher price. Smallholders should also be charged for the same price, and not be subsidized. The reason is that a soil sample analysis is a private good that costs money, but when the results are applied correctly, revenues (higher yield, improved quality) are a multiple of the costs. Shifting towards commercial agriculture implies also increased cost-consciousness.

Losses

In the start-up period (maybe a few years until the lab is accredited), the lab will have higher costs than revenues, causing a net loss. It is recommended that a public party such as the Dutch embassy will compensate this cost. This is consistent with their strategy to support agricultural development and to be involved temporarily in those specific projects.

Revenues

It is also important that the lab will keep control over the revenues. Revenues need to be used for compensating costs among with costs for maintenance and reinvestments. As soon as the lab makes profit (revenues exceed total costs), the profit can be used for additional investments such as more advanced techniques, expansion in sample size capacity or adding new types of analyses, broadening the scope of the lab.

The costs of the analysis if done by IIAM are given in table 7. They are compared with laboratories in Nairobi and other laboratories in the USA. Cost for soil analysis in Maputo and Nairobi are comparable and these laboratories are cheap compared with the USA laboratories. Prices of IIAM are higher than the prices of Omnia in South Africa (Approx. \$10 for soil fertility). . This fertilizer company does the soil analysis as additional service to fertilizer sale and use only their internal costs. They estimate the commercial price in other laboratories to be approx. \$30.

Table 7. Costs of soil analysis in different laboratories

| Test | IIAM Maputo KARI Nairobi | | USA Institutions | | | |
|----------------|--------------------------|-------|------------------|-------------|-------|-------|
| | | | U Georgia | U Minnesota | NAC | MSTS |
| pH in water | 1.75 | 0.67 | 5.00 | 4.00 | 8.00 | 5.00 |
| Soil Texture | 7.75 | 5.33 | 15.00 | 17.00 | 15.00 | 20.00 |
| Micronutrients | 8.00 | 9.33 | 15.00 | 11.75 | 16.00 | 16.00 |
| Total N&P | 7.75 | 10.67 | 15.00 | 16.00 | 15.00 | 20.00 |
| Inorg N | 9.50 | 6.80 | 7.50 | 10.75 | 8.00 | 12.00 |
| Organic C | 5.25 | 2.93 | 10.00 | 13.25 | 8.00 | 12.00 |
| Total P& K | 5.50 | 6.67 | 10.00 | | 8.00 | 10.00 |

5 Interest and advantages for partners in the Public Private Partnership

5.1.1 Interaction of partners

Interest in the result is the first condition to start a partnership and a partnership should have advantages for all partners involved if not on the short term, they should be present on the long term. In this chapter we describe possible advantages for the partners involved. Also in this chapter we have our focus on the Beira Corridor. The list given below is not comprehensive and more advantages will probably be identified during the development of the PPP. Having an open mind will be important for all partners.

In the development of the laboratory, farmers, research, education and advice sector will play a role. In the start-up phase of the laboratory the role of the farmers will be played by the commercial farmers. Small farmers will be involved in a later phase by interaction with the advisory sector and the commercial farmers and their involvement will grow in time. The different interactions are shown in figure 13. In the figure fertilizer industry is included in the advice block. Important in figure 14 are the interactions.

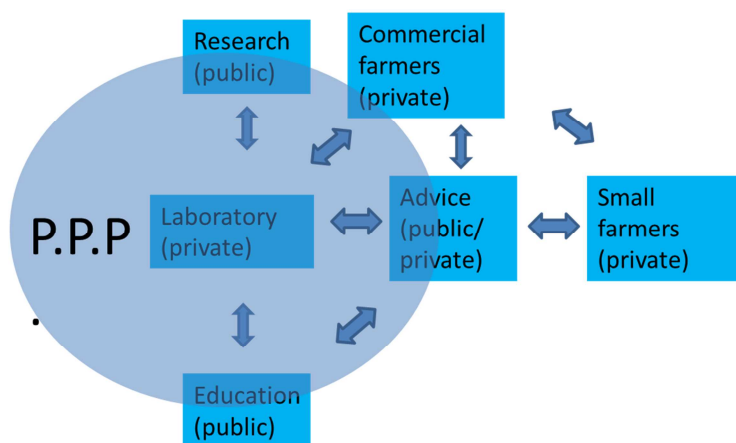


Figure 14. Involvement of different partners in the development off the laboratory

5.2 Public sector

5.2.1 Ministries

The ministry of Agriculture is responsible for the development of agriculture in the Beira Corridor and has to take care of a proper infrastructure. Most of the infrastructure (market, roads) is beyond the scope of this project but some are related with an advice laboratory. Having a laboratory and proper advices will increase the yield of agriculture. The money related with this extra yield can be invested again in the agricultural sector. Proper advices will also prevent that a too large excess of nutrients will leach to ground- and surface water,

which can be an environmental problem in the future. Using the partnership in the foreseen PPP, the ministry of Agriculture will be able to show leadership for the development of agriculture in a broader context.

Because small farmers as private partner are not organized, there is a public responsibility to support the interest of these farmers in order to increase their yield per ha, to improve the quality of the product and to give them access to commercial farming. The Ministry of Agriculture or Regional Directors have to take on this responsibility.

Education on Agriculture is the responsibility of the Ministry of Education. The ministry wants to improve the practical skills of students. We think that this can be achieved by development of desired curricula. Practical work in the field and in the laboratory should be included. Laboratories have to be equipped on such a way that the theoretical part of the study is practically supported.

5.2.2 Research centre IIAM

The laboratory will produce a lot of data, also interesting from scientific point of view. Data can be used to improve maps, but also in research to new sophisticated ways of advice. For instance including remote sensing data and weather forecasts in giving detailed information to farmers. The internet and mobile telephone (smartphone) may have an important function in such a development. Data can also be used in research projects on the development of soil quality. Therefore, having access to the data produced by the advice laboratory has to be organized during the first steps of the planning of the PPP.

There are several methods that can be chosen for soil analysis. For instance for phosphate analysis about 15 different methods are used worldwide. During set-up of the laboratory choosing of methods to be applied will be one of the items. Involvement of IIAM will ensure that methods used on the advice laboratory and in research will give comparable results.

The presence of a strong commercial laboratory will make IIAM less receptive for failure in her own laboratories and overloading of her own laboratory capacity. In a good cooperation, experience can be shared and reagents and supplies can be borrowed from each other. IIAM will also have the choice to use own laboratory capacity or have samples analysed on the advice laboratory especially in period of a high supply of samples of research projects. Outsourcing of analysis in a project can be interesting, both from financial as management point of view.

Having the advice laboratory it will not be necessary to develop such a lab in Sussundenga. This research facility can use its energy to enable activities that should be close to the experimental field and special activities.

5.2.3 Educational centres

The advice laboratory can play a role by offering internships for students with special interest in soil- and plant tissue analysis. The service laboratory can also play a back stopping role for the education laboratories for instance in maintaining equipment and supply of reagents, glassware and small tools. It is not necessary to have these for free, but ordering of these items will be almost daily practice for the advice laboratory and very difficult for an educational lab.

5.3 Private sector

5.3.1 Large and commercial farmers

Using the laboratory results, large and commercial farmers will increase their production. Having the laboratory closer to their farms the whole procedure from sampling to advice will be more efficient. As soon as the laboratory is also able to analyse plant tissue, a further increase of yield and quality will be possible and also a more effective use of resources.

5.3.2 Small farmers

Because they are not able to judge the importance of soil analysis, small farmers have no interest yet. It is also in the interest of all other partners that the agribusiness in Mozambique develops and increases. This means higher yield per ha, an increased cultivated area, and increased export. This requires that small farmers will be involved as soon as possible. Involvement of small farmers means the use of fertilizer and for the laboratory it means that more samples will be analysed.

5.3.3 Laboratory sector

Although not strongly developed in Mozambique, the national and international laboratory sector has to be involved and it should be discussed how. The laboratory sector is probably the most important candidate to run the laboratory in future. Omnia, Swiss lab and Intertek have already taken part in interviews and discussions during the mission, but also existing international soil laboratories and advisors can be involved. During preparation of the mission we have visited BLGG in Wageningen. This laboratory organizes sampling, analysis and advice to farmers.

5.3.4 Fertilizer sector

Laboratory results will lead to advices on the use of fertilizers and also on the composition of the fertilizer. Fertilizer industry must be able to produce and deliver the desired fertilizer. They can expect an increasing market and have to be involved in the PPP.

5.3.5 Advisory sector

Because it doesn't exist yet, this sector cannot be involved in the PPP. As mentioned advices are important and have to be included. This can be a task of the PPP, but can also be developed in a separate PPP. Organizing the advices have to be part of the business plan.

5.4 Management of the laboratory

The main goal of the soil lab is commercial application, serving commercial farmers and smallholders in maintenance of soil fertility, increasing yield and improving product quality. This kind of lab can be operated fully privately. It is therefore recommended that in the management structure private parties dominate. However, public money is invested in the preparation of the lab in order to enhance agricultural development in general, and shifting smallholders towards commercial farming in particular. This requires that the private lab also contributes to public goals. Those goals are (1) providing education possibilities at the lab, such as internships and demonstrations and (2) providing the sample data to research institutes such as IIAM and universities for analysis on behalf of generic recommendations to improve soil fertility. This knowledge has to be public. Extension workers connected to farmer's cooperatives and unions can use this information to tailor the advice to smallholders.

In order to safeguard public goals, a board of directors is needed at the start of the lab, in which private parties dominate owning 60% of the votes, and public parties (among others the Mozambican government) own the remaining 40%. Furthermore appointments have to be made how the public responsibilities have to be served. Those appointments need to be fixed by contract.

6 Recommendations how to continue, a step wise approach for Mozambique

In this chapter we combine previous chapters in an advice for the agricultural sector in Mozambique to start a soil laboratory. This advice has to be considered as a proposal. We do not want to prescribe exactly what to do; this is the responsibility of the stakeholders in Mozambique. We only want to facilitate the discussion and to deliver tools.

6.1 Focus of the laboratory

One of the first aspects to decide is the kind of analysis the lab can focus on. The following criteria can be distinguished:

1. Which analysis does most contribute to shifting subsistence farming to commercial farming?
2. What is the amount of money to be invested in equipment

On the basis of these criteria, the laboratory will start as a lab analysing soil fertility. This kind of analysis has been chosen because most of the smallholders don't apply fertilizers. Fertilizer use will be a first step for smallholders to shift towards commercial farming. Although most smallholders are not able to interpret soil sample analysis results, and need advices, this is a next step necessary for fine-tuning the soil fertility and increasing yield and quality of the crop. Furthermore, no advanced and expensive equipment is necessary to start soil analysis.

The choice for a soil laboratory enables a number of analyses additional to soil analysis. In the first place, plant tissue analysis can be added in order to analyse mineral deficiencies. The results can also be used for fertilizer application. The additional investment is rather low. Secondly, there is a strong need for testing commodities such as peanuts on aflatoxins, which is important for safeguarding food safety.

On the long term testing plant tissue on residues of pesticides serving food safety can be an additional service. These analyses become important when the shift towards commercial farming results in an increase in exports. Finally the lab services can be extended by testing plant products on the presence of pests and diseases. For phytosanitary purposes, products which are infested cannot be exported. In this case, the testing is on biological rather than on chemical content, which needs other equipment. An extension of chemical testing can also be shifted towards other sectors such as environmental testing and testing for minerals on behalf of the mining industry. If all these analysis on food safety and environment have to be included in the soil laboratory will depend on the development of the laboratory sector in Mozambique. We recommend that these types of analysis are not considered in the discussions necessary to establish the soil laboratory.

6.2 Organization of the laboratory

A soil laboratory for soil fertility gives service to farmers and this service can be organized in a private organization. To come to such an organization it is necessary to make use of existing knowledge and experience in the public sector of Mozambique. To make the laboratory successful, we think that a PPP is a proper construction to start with and this PPP should develop into a private enterprise as soon as the market

for soil analysis is sufficient developed. Going from the present situation with no soil service laboratory in Mozambique to a PPP followed by a private enterprise a step wise approach is necessary.

6.3 Step wise approach

We recommend using a step wise approach separated by Go/No Go decisions. This will prevent that large amounts of money will be invested in a facility with too little support. First large investments will be necessary after step 4.

Step 1

As soon as this project is finished, the results have to be adopted and we suggest to appoint a coordinator. In this phase the coordinator should have an independent position. The coordinator needs support from a platform in Mozambique with experience in the construction of PPP's and having a focus on the Beira Corridor. We think that BAGC is the proper organization to give this support. The quality of the coordinator in combination with local support is essential for the success of the following steps.

Go/No Go

Step 2

First tasks of the coordinator are:

1. To find a public party interested to become fully responsible for the laboratory in Mozambique. The public party can be a single party, but also a consortium of parties. Involvement of a private Dutch party can be considered.
2. To explore Programs (The Netherlands, Mozambique and International Institutions) that give possibilities to support the activities. Dutch examples are Matchmaking Facility Development Cooperation and Private Sector Investeringprogramma (PSI).

Go/No Go

Step 3

Having the private partner(s) with potential to run the laboratory, the following tasks have to be executed by the coordinator, in cooperation with the private partner:

1. To select other private partners and public partners, Annex 12 gives a list of parties and names involved in this project.
2. To define the role of the different partners and also future changes of the roles.
3. To elaborate the management structure in PPP (short and long term; lab manager + board of directors) as described above.
4. To elaborate the terms of Reference for ensuring public responsibilities.
5. Appointment of the board of directors
6. To quantify the actual demand among commercial farmers in the Beira Corridor and where their soil samples are analysed. The commercial farmers have to be contacted and asked for their willingness to make use of lab services in the Beira Corridor. The quantification of the demand is necessary to justify the start of the lab and to assess the risks
7. To prepare the decision on the location
8. To take the initiative for getting technical staff trained in the Maputo lab
9. To appoint the lab manager

Go/No Go

Step 4

If step 3 has been successful, the coordinator has the responsibility to assure that following tasks are performed by the lab manager:

1. To develop the lab infrastructure. A design of the lab has to be made: building, lay-out etc.
2. To make choices for instrumentation.
3. To develop the business plan
4. To allocate the availability of funds in national en international programs.
5. To elaborate a long term budget
6. To develop the maintenance plan for the equipment: funds, where to find skilled external technicians
7. To develop a plan for expansion of lab services in a logical order.

Go/No Go

Step 5

When step 4 has been successful, the lab can be established. This requires the following activities:

1. Building the lab
2. Buying equipment and consumables
3. Executing the business plan
4. Communication of the existence of the lab in order to get samples submitted.
5. Appointing trained technicians
6. Starting analysing soil samples
7. Start organizing advices based on the laboratory results (PPP)
 - a. Organization
 - b. Education
8. In this phase the role of the coordinator will end and the laboratory manager will take over the main responsibility.

Annex 1 Interview of Sunday June 24

Report interview dr. Randolph Fleming, USAID AgriFUTURO Project

He is active in the agricultural sector in the Beira region and in the north of Mozambique. They support policy initiatives for stronger farmer operation and public private cooperation. It is difficult to locate financial funding, because the banks do not like to invest in agriculture. They are supported by the US agricultural department, World Food Program, Ministry of Agriculture and Ministry of Technology IITA, IIAM

Haman capital, proper trained people is lacking in the country. Needs hand-on practical training including laboratory analytical capacity. Good seed material is seriously lacking. Having seed integrity lab would ensure viable seed to the farmers.

It is important to have a chain of certified laboratories in Mozambique, Maputo, Chimoio and in Nampula. The latter is already certified. He mentioned also the laboratory of the University of Lurio in the north. ISPM is constructing facility which will include soil and plant testing. They have some equipment but additional support has been given through INTERTEK for lab equipment. They cooperate with Intertek, which uses a laboratory in Beira and for difficult analyses the go to Johannesburg.

There is lacking of soil information in the country. Existing soil maps were conducted long time ago and the scale does not provide sufficient information for better decision making. We need map with small-scale.

There is need to explore soil amendment using liming material locally available.

Potential partners working with AGRIFUTURO, USAID, WFP (providing kind of financial support to UNILURIO-Nampula), IITA, IIAM, and Ministry of Science and technology.

For their work it is important that a laboratory is able to analyse:

- Aflatoxin, which is a toxic compound produced by fungi in maize, groundnut- and cassava products, if they are stored on a wrong way; too wet or in plastic bags worsen the situation. Aflatoxin stimulates liver cancer and affects the development of children and Livestock. From commercial point of view maize and cassava are difficult to sell to end customers (for export) if it is not free from aflatoxin (quality certification). Proper storage and promotion of jut bags may decrease the formation of aflatoxin.
- Quality of seeds, germination. Mozambique is used as dumping site for old seeds and farmer use part of previous harvest as seed. Better seeds will increase the yield, but quality of seeds has to be guaranteed.
- Nutrients. Fertilizer factories are in an early stage. Moz Fert one of few fertilizer manufacture company which does blending from fertilizer elements.

The following aspects needs attention

- Training of people working in the lab. Training is part of the initiatives they are working on.
- They work on the campuses of both UNILURIO, in Nampula, and ISPM, just outside of Chimoio, to develop fully equipped and certified laboratories. In the case of the ISPM laboratory, the government is fully funding the construction, while in the case of UNILURIO it is partially doing so. In both instances, the building has commenced although it is much further along in the case of ISPM In both cases, funding has been identified to supply equipment for a regular soils laboratory although in neither case is there a foliar component as well, which would be helpful. There is already an old lab at UNILURIO
- The equipment is funded. There is no capacity for Aflatoxin analysis.
- In the case of UNILURIO, some funding has been made available to help with seed integrity assessment although that is still not covered in the case of ISPM.

- Soil maps have to be further developed and are not detailed enough. There is an organization responsible for soil maps. Results of laboratory may feed this organization

The following contacts can be interesting

- Dawie du Plessis, the representative of Intertek
- Dr. Tito Fernandes, Eduardo Mondlane University in Maputo but who also has done a lot of work at UNILURIO in the north
- Dr. Jorge Ferrao the Rector of UNILURIO who is certainly very intimately familiar with the entire program at that school and would be a good source of further information about what they are trying to do
- Dr. Rafael Massinga the Rector of ISPM in Chimoio.
- Dr. Americo Uaciquete who is managing the lab at UNILURIO but who is also involved in various laboratory programs with IIAM based in Nampula
- Tracy Wyman who works at the Ministry of Science and Technology and would be a knowledgeable source of additional information
- Charlene McKoin, the Chief of Party of the Program, To be contacted if dr. Randolph Fleming is not present. (July 4th to 23rd)

Annex 2 Interview of Monday June 25

Report interview dr. Emerson Zhou – BAGC

Partners of BAGC are:

- Ministry of Agriculture through CEPAGRI (Centro de Promocao da Agricultura = Agriculture Promotion Center). CEPAGRI appointed as representative of the MoA.
- Dutch embassy
- Private agribusinesses
- Donors (public and private)
- National Farmer Union (UNAC = UNIAO NACIONAL DE CAPONESES)

Objective: enhancement of commercial agriculture. At this moment less than 3% of the area is commercial. Constraints are lack of irrigation, no electricity, lack of financial services, road, etc. Agriculture has disadvantages compared to other sectors: production cycles. Specific features of agriculture are not recognized. Interest rates are very high (20%).

There is limited technical knowledge about the Beira corridor. That makes the finding of technical educated staff difficult. Graduated students have the certificates, but lack the necessary competences. Therefore the technical skills and good plant varieties lack. The BAGC initiative is trying to invite private firms to invest in the development of the BAGC corridor. Provide technical support services. Provide knowledge about local conditions. We have 2 development windows:

1. The Catalytic fund: providing lower costs finances (5 -10%) for start-up ag business
2. AgDevCo: Invest in commercial and small-scale farmers

BAGC has a partnership with AGRA, directing AGRA investments in the corridor; World Bank in irrigation scheme.

Challenges: Agriculture entrepreneurs to pay the services.

With regard to the soil and plant tissue lab:

- Is it accessible?
- Is it affordable?

Small scale farmers (less than 1 ha approx.). Commercial farmers are present, but are very scarce. Mineral fertilizers are almost not used. But an increase is expected (about 5 years or more). Promotional work is going on. Farmers lack general guidelines for application of fertilizers.

We have to analyse the demand for services such as analysing samples. However the demand of small scale farmers is indirect. They need generic advices, which result from analysing soil samples. Therefore the direct demand for the soil and plant tissue will be limited. Demand has to be created in order to enhance the use of mineral fertilizers and to provide detailed advices based on soil sample analyses. However the cost recovery capacity of extension is limited.

Large scale farmers have a higher profitability and can pay a higher price for services, but not too much. A soil testing lab cannot be run with only private money. It is recommended to extent the lab with other services, such as seed testing, etc.

BAGC is developing a database with data about the farmers and their location in the Beira corridor, but it is not yet ready.

BAGC promotes the concepts of service centres.

ISPM (partner from BACG) is also developing a lab. They will mainly apply it for their own interest, which is doing research.

The key issue is that we need a laboratory. It must be able to run with only private money in the long term. We need public money to reach that desired level.

Fully commercialized lab may not be good option at the moment. Agriculture is at early stage in the corridor and there is limited demand for soil testing and fertilizer in the movement. But the demand will increase.

Harare and South Africa are current farmer's alternative for soil testing

The catalytic fund is not the proper fund to invest in the lab. The partnership has to seek for public resources.

There is no private initiative to start a lab, with a business plan which can be supported by the catalytic fund.

Conclusions are:

1. There is an existing need for lab services. We need to provide a solution how these services can be delivered.
2. Starting a lab is a private responsibility. Running a lab in the long run when it is fully operational is a private responsibility.

It is desirable to have not just soil lab but multipurpose lab.

Annex 3 Interviews of Tuesday June 26

3.1 Report interview Suzie Aline and laboratory staff - IIAM

Suzie Aline is working at IIAM, soil fertility division and she is participating in the fertilizer quality control project lead by the National Directorate of Agricultural Services (DNSA). The project has different components: 1) development fertilizer regulation, 2) Create local human capacity for QC of fertilizer; 3) Setup lab in major entry point of fertilizer in the country for checking and certifying fertilizer. The idea is to develop 3 or 4 soil labs: 1 in Maputo, 1 in the center (Chimoio or Beira) and one in the north (Nampula or Nacala). Assessment team will work in the coming weeks in the Nacala corridor for deciding where the lab should be located. It is not easy to start a lab. There is lack of skilled people in fertilizer analyses. We need equipment which are expensive. In Mozambique no people are trained in fertilizer use. So we need help and we have involved AGRA in this project. Trainings will be organized, maybe by consultants working in Kenya. The first training is for key persons in IIAM, in India. The second training will be for technicians in Mozambique, following the training the trainers principle. Training is a most important issue and should be done before equipment is installed.

The fertilizer lab in the center of the country can be located in Sussundenga, where a research station of IIAM is located. No contacts exist with ISPM in Chimoio, who is also intending to start a soil lab. It must be kept in mind that a fertilizer and a soil lab serve different purposes although equipment can be used for both.

Furthermore combining lab services increases the critical mass.

The idea is to start the lab in Maputo, which will be the reference lab. Employees can be trained. Afterwards a duplicate will be started elsewhere in the country. This guarantees that the working procedures are the same, which is important from an accreditation point of view. This is also important from the financial point of view. Funds are not enough. If we can demonstrate how it works and that it works, it is easier to raise additional funds. Furthermore there should be a procedure to safeguard revenues of the first lab to invest in subsequent labs. This should be discussed with the Ministry of Agriculture.

Joop asks for the methods which will be applied. These will be sent by email to him.

How are the responsibilities arranged? Factories should have their own quality checks, which can be applied quickly. The government is responsible for the quality of the processes in the factory.

Augusto Siteo and Mario Julio from the soil lab join the discussion.

Augusto explains that the soil lab is the central lab in Mozambique, analysing around 1000 chemical and physical parameters. The capacity is 5000. The lab faces a lot of problems with the equipment, reagents and supplies. The lab lack proper safety to reduce exposure of the analyst to the chemicals. New equipment has to be bought from abroad. Maintenance of the equipment is important. The technical background of the technicians is good, most at medium some at higher level. Most of them are trained in Mozambique; some are trained in the Netherlands and in the UK.

It is necessary that a consistent financial system will be developed that enables the lab system to work properly. Income from analysing should be used to cover the direct costs of each sample at first, the equipment costs (maintenance, investments) secondly, and salary costs thirdly. It should be discussed if the government agrees with a system that revenues are directly used for investments in the lab system.

Nurbibi Cossa responsible for virology attends the meeting

It is important to have technicians which are able to do the first line maintenance of equipment.

Conclusions:

1. IIAM has skilled staff for lab services:
 - a. Soil
 - b. Plant tissue
 - c. Seed quality.

2. The problem is that part of the equipment is not functioning properly because it is damaged or it is not properly installed. Skills for first order maintenance are not present. Most of the equipment is imported.
3. If the above mentioned problems can be solved, the IIAM lab can function as a national reference lab.
4. Revenues of a well-functioning lab, which applies its full capacity, can be invested in further development of lab services and afterwards in duplicating the lab to Chimoio and other regions of Mozambique.
5. It should be investigated whether the initiatives to start labs in Manica should be combined in order to create synergy and sufficient critical mass. Current initiatives are:
 - a. (Private) soil lab (this project)
 - b. Research soil lab of IIAM in Sussundenga
 - c. Lab at ISPM for training purposes.

3.2 Report interview Daniel Clemente (Permanent Secretary), Dr. Ventura Macamo (Minister Advisor) and Gertude Muchave – Ministry of Agriculture (MoA)

Jan, Sergio, Joop, Johan and Ricardo explain the objectives and ideas about the project. Mr. Clemente thanks us for coming to identify the need for a soil and plant tissue lab. We give you support to locate the lab in the Beira Corridor because of the great potential. Sending soil samples to South Africa is expensive. If it is possible to discover the combination of public and private money that would we greatly appreciate. We need to support agricultural extension services. In Chimoio we also have a Centro Zonal already. Linkages with other regions can save costs. We have to certify all the steps: part by part, lab by lab. We can apply the system maintained by WEPAL.

The MoA is eager to see the outcome of the mission and suggested to have brief meeting with adviser of the MoA, IIAM general director and other relevant MoA staff at the MoA, besides feedback meeting to be held in the embassy.

3-3 Report interview dr Maposse - Director IIAM, Dr. Calisto Bias¹ and Dr. Manuel²

Joop summarizes our experiences so far with regard to the project to investigate the feasibility of a soil and plant tissue lab in the Beira Corridor. We have done this with an open mind. We have to investigate the demand for the services and to elaborate a development model. We have this morning spent at IIAM. We have seen that the skills and motivation among the employees is present. The problem is the equipment which is partly broken and cannot be repaired. The revenues go to the ministry and are not used to maintain equipment.

Brief previous meeting with policy maker: The advisor of the minister of agriculture and permanent secretary gave their opinion about business model and potential locations for setting a soil and plant tissue lab. The PPP could be an option. The BAGC was mentioned as an example of PPP. They welcome testing new management models or improving existing management model.

Dr. Maposse explains that IIAM wants to grow, but we still face difficulties. IIAM needs a lab. But funding has been limited to create a soil lab. We see ourselves as a research institute which serve agriculture, Colleges to educate students, but also for our own developments. At this moment we can reinvest 60% of the revenues. We fight for 100%. In that case we can earn more money.

Dr. Bias: you should ask for support the public labs. They can grow to examples for private initiatives.

We need to consider legacy of intervention. It would be more appropriate having public lab so it could serve both small scale farmer and private sector.

IIAM central soil laboratory needs to be reequipped. It was staffed by the Dutch government several years ago. But financial resources to do so are scarce.

Sending samples to Maputo is costly and it is not viable option. The country is too big and there is time delay to have the results back to farmers.

Human capital is an important issue. IIAM has well trained people to provide good services to farmers.

The soil lab should also include environmental aspects and GIS-aspects. A holistic view is needed. Joop answers that it is not the objective of a research lab to focus only on analysing samples for farmers. That is a private responsibility. However the current lab can contribute to the development. The revenues can be used to invest in the own development. A good network of labs serves both public and private objectives.

The creation of soil lab should fall into Ministry of Agriculture research development capacity. It should strengthen Zonal research centre capacity. Mozambique research is organized in zonal research centre (there are four and Sussudenga is one of the four)

Extension system has a role to play in advising farmers and awareness creation which would create demand for soil lab services. But extension system needs to change.

There is little knowledge about our soils. This serves would contribute for better understanding of our soils.

The same model can be applied to analysing commodities on the presence of contaminants. However, to our opinion it is a step further. Training of people is included in the system. Furthermore we have to develop the advisory sector, because the analyses need to be accompanied with an advice how to apply the results.

The results of our project are recommendations about the

- Location of the lab
- A business growth model that works in future
- Shifting from public to private funding

We will also highlight challenges for IIAM. It is your task to take them up.

¹ Dr. Calisto Bias – Coordinator of PROSAVANA Triparty (Mozambique/Japan/Brazil) initiative

² Manuel Amane – Technical Director of the Department of Agronomy and Natural Resources

Annex 4 Interview of Wednesday June 27

4.1 Report interview dr Antonieta - Director PIAIT

Joop explains the objectives and discussions we have already had. Dr Antonieta agrees with the approach of a growth model. She stresses that a laboratory needs a sustainable approach and has to be located in the region of the Beira Corridor. The lab will start as a public good. She made a comparison with an animal lab, providing vaccines. At the start, vaccines were free, but now, farmers have to pay for that. In the beginning may be difficult but later they will pay for the services. This way we create demand and improving farmer's product. The local community has to be aware that they have profit by buying lab services. The market has to be created, which is not easy.

What is the role of PIAIT? PIAIT is an initiative not institution. PIAIT is a platform to bring all the partners interested in development of agriculture together, in order to bring their results to the stakeholders, such as farmers and growers. The idea started with CGIAR (Consultative Group on International Agricultural Research) institutions working with IIAM. The knowledge transfer to the users is central to PIAIT. This initiative is coordinated by UGP (Unidade de Gestao da Plataforma = Platform Coordination Unit). This initiative is funded by USAID. EMBRAPA for instance is working with IIAM in strengthening local capacity as well as transfer existing knowledge developed in Brazil with similar conditions with some regions in Mozambique. The focus is on extension services, both public and private (supported by NOG's). Special attention is paid to smallholder farmers. My experience is mainly with livestock producers. Innovation platforms seem to be a proper way to approach them, which have to be organized regionally. Barriers are culture. It is important not only to tell them, but also to show them advantages by field experiments. Local research and extension stations have to be used. PIAIT is dependent from public money, and has no experience with demonstrations financed with private money. There examples with traders in cash crops such as tobacco which have their own extension workers. The Centre Internationale Agriculturo Tropical has also good examples how to disseminate results. You could also consult them.

There are many challenges: The number of extension staff is very limited. The MoA recognises that and strategic plan will address this. Currently the focus of agricultural research has been smallholder farmers. Innovation Platform could be one way to create demand for services. This could be done at regional level and extension and research needs to participate.

Current research cost and extension are fully covered by the government (seed, fertilizer are provided to the farmer free of charge)

4.2 Report interview dr Alexandre - Director Swiss

Joop explains the objectives and discussions we have already had. Dr Alexandre explains that the largest obstacles are running a laboratory. Most technicians have no idea about the costs of equipment and reagents. The government charges clients a symbolic fee which does not cover the variable costs, so we are always too expensive. On the other hand they do not provide information about the results. The money we get is from environmental testing. Our competitors are in South Africa. It is a small market. Our clients are private companies (mining industry), FAO, construction industry (soil contamination).

My advice is if you do testing about contamination of the soil or commodity, you have to tell them about the solution, otherwise you will create panic.

He tells a number of stories about the current practice of e.g. water testing (drinking water, bottled water) etc. The procedures give a lot of space for manipulating results. The pressure of private companies is much higher, so they need real information. Our competitive advantage is they our lead times are quite short, which

is important for microbiological testing. Furthermore, South African companies are quite overloaded. We follow the interlab testing with South Africa, to keep our quality standards.

Accreditation keeps a lot of pressure on us, because of short time to make adjustments. We follow the Portuguese accreditation system. We hired two consultants for almost 9 months to describe the rules. Accreditation makes the costs high.

Another problem is the customs. They always look for possibilities to make barriers, although we always literally follow the procedures.

Furthermore, maintenance is a problem. We only import equipment for which local support is possible. Maintenance is expensive. Technicians have to be flown in, most of the times twice: first for diagnosing problems and the second time for replacing elements.

Government prices are not competitive to make a lab sustainable and data is generally questionable. Cheaper price makes difficult to compete. Lab may pay the services. He suggests that government lab should be for monitoring purpose not for routine analyses. Government owned lab face several challenges. Problems with maintenance of the equipment, lab supplies, data quality, bureaucracy, etc.

Much of SWISLAB work is from environmental testing, food area still limited. Some areas are profitable some are not profitable. Major clients are FAO in soil testing for pesticide contamination, River and streams water testing, construction industry.

The time lag between sending the samples and getting results back is about 3-4 weeks if analysed in South Africa, but now they can have results back if analysed at Swisslab in 3-4 days period.

They can collect the samples or client can bring the samples. It is important to state that in the former situation the analyses will represent what is being provided to the lab because they do not know how representative sampling was.

They are working on accreditation. In the future, in Mozambique INNOQ may be an accreditation entity. There couple of companies proving mail serves among them DHL is the best one specially is you have products that needs cool system. Other companies do not have such facility in the airports.

4.3 Report interview representatives of Omnia (Ken McKenzie, Francois Erasmus and Vossie Wilsnach)

Omnia is the largest fertilizer producer in Southern Africa. The company has a team of agronomist working with farmers. Because some people do not know what to do with soil data. Chemtech is the lab: fit for quality control. The volumes are: 100.000 samples per 3 months. Omnia bases his recommendations on the results. We believe that there is a good opportunity for establishing a lab in Mozambique. We can support this, especially financially. OMNIA is planning to expand their business to Kenya, as flower culture industry becomes more attractive business. If farmers can make money, they can buy fertilizer for improving production. However, in Mozambique subsidizing fertilizer limits farmer's ability to buy fertilizer by their own. OMNIA blend fertilizer according the farmer's needs.

Of a total of 7 lab 5 OMNIA's lab are quality control labs other are research labs. They have high skilled personal with technical hub in soil science, chemistry.

From Chemtech we focus on agriculture. We are ISO 17025 accredited, AGRILAZA. We have core analysts which are yearly trained. We are running two ICP's for soil samples and spectrometer. ICP's can be broadly applied. The analysis takes about 5 working days. The whole process is electronically documented. We also analyse tissue samples within 48 hours. Now they also do plant SAP analysis and diagnoses nutrient deficiencies for fertilizer recommendations. Fertilizer and soil samples are totally separated. Additional staff for analysis is hired when the volume of soil samples increases.

Omnia and Chemtech invest in smallholder farmers, because they believe that if they understand that they can make money, they need fertilizers. We have experience in Malawi and Zambia, with groups of smallholders. The problem is that subsidized farmers will always be subsistence farmers.

OMNIA is willing to work on knowledge transfer. Technically, setting a government lab may not be a problem but sustainability may be a challenge.

Mozambique has excellent resources. Politically stable, good ground water, good climate conditions, soils but slow agricultural development may be because private sector has not the potential that the country offers. OMNIA is working with Dutch government in South Africa for supporting small-scale farmers. The experience and knowledge could be transferred to Mozambique.

Sending samples from one country to another is difficult because government regulations. Therefore setting a soil lab in Mozambique makes sense.

It is important to note however that commercial farmers have capacity to send their samples to SA and their agreement between customs with the company. The cost of soil analyses is diluted if one send huge amount of samples and gets fertilizer from OMNIA.

Research laboratory might have high price for soil testing because the volume.

It is important to assess existing conditions before setting a lab. Sometime investment is made but people do not use the facility.

Do you have problems with lack of independency? The ISO 17025 system prevents this. When auditors suspect manipulating results, we lose our accreditation.

With respect to research: it is not necessary to locate this in Mozambique. We don't need to reinvent the wheel. Results of research in South Africa can be demonstrated in Mozambique.

They are convinced that Mozambique is at the beginning of the golden agricultural century. It has plenty of fertile land, especially in the north of the country. It has a stable political regime. Foreign investors take a long time before they start to invest. They are at that stage right now, if they can find enough land between the mines. However, development can only take places in PPP's. We are happy to participate.

A lost costs about 120.000. From a business point of view, it is not profitable to start a lab in Chimoio. We got the same question 3 years ago from USAID. From a development point of view, the answer can be different.

Possibilities for equipment maintenance are limited in Africa. Pre-treatment facilities in the region are not very attractable, because when two parties cooperate, it is always the other's fault.

There are already difficulties with exporting soil samples. Some countries are suspicious that e.g. gold is smuggled.

Prices are for routine soil samples 4€, for advanced analyses it is higher. They will send us a pricelist.

Annex 5 Interview of Thursday June 28

5.1 Report interview customs

The representative asks for the investment which is between 100.000 and 200.000 euros. Before equipment is shipped, a letter has to be sent to the customs in which everything which is imported is listed and explained, item for item. The same applies for reagents. Within a week the answer can be expected. No exemption will be given to the goods received before official approval of the request for exemption. Is it possible to involve the custom in the PPP, for advice during the establishment of the lab? Yes.

IIAM could budget the cost of importation by including in the annual budget that goes to the ministry of finance and later can use the budget line to pay customs duties if not exempt.

All equipment for research is exempt of customs duties.

The letter requesting exemptions should be sent to the Minister of Finance through customs authorities.

If it totally private investment the proposal needs to go CPI (centre for promotion of investment) and will be subject to customs duties.

Report interview private consultant for customs services (Filipe Guiamba)

Normally it takes 1 to 1.5 month to get permission for importing equipment after the fees have been paid. The challenge is not only to get permission for the equipment, but also for components which have to be replaced. For the last things short lead times are important. For equipment and components, separate lists have to be presented. Public institutions have faster procedures, because they have access to the treasure account. This can complicate the PPP construction: a public account is preferable for customs procedures; private accounts are preferable from a commercial point of view, in order to reinvest revenues in maintaining equipment. The custom fee is around 25%. This could be reserved publicly. It is possible to combine spare components to be subject to one procedure. Some products imported from South Africa (SADC-certificate) are free from fees and custom procedures. The certificate is needed prior to shipping. What is the best procedure: by plain or by boat? By plain, the procedure is cheaper. Importing by car from South Africa is also an option. There are three major costs if shipped by sea which increases overall cost:

1. Ship
2. Cargo handling
3. X-ray check of the container

Web based clearing procedure were established in the airport. Payment and check of the status of custom clearness can now be checked in the internet when the goods come from cargo. The serve will soon be expanded to shipping by sea and road. In the near future, a one-stop-shop at the Mozambican – South African border will be established. Maputo and Beira and other main ports have already applied the unique-clearance window where all necessary procedures can be dealt with.

5.2 Report interview CEPAGRI – dr. Mussuale and mr. Nhangombe

We explain the objectives of the project: gathering ideas and development of a business plan. To the opinion of CEPAGRI, a lab should be run public, comparable to research. The results serve every farmer. If it is run fully private in the beginning, there will be free riders. A public body is necessary for bearing the risks. CEPAGRI will provide key figures of agriculture in the Beira Corridor region.

To our opinion more services should be provided than only analysing soil services. We need extension services, analysing seed quality etc.

CEPAGRI brings together smallholder farmers, traders, local authorities, extension workers, in order to establish necessary linkages in the network to create a sustainable system of commercial agriculture. Market

power of the trader can be a problem. If farmers cooperate in farmer unions, they can build up countervailing power.

CEPAGRI welcomes the idea of PPP because would make sustainable investment. It is important to have figures of the investment.

Participation of the government is important because will protect the investment, reducing the risk.

CEPAGRI promotes investments which would contribute to improving agricultural development, enabling the change of smallholder farmers to medium-scale farmers.

We also have to look to the value of the crop. The higher the crop value, the more farmers are prepared to pay for inputs, such as fertilizers. Farmers are prepared to shift to new crops such as sesame, because it has a higher value, and faces little plant health problems. Smallholder farmers change the use of land. This is important for the system in which the lab fits. If farmers do not built up knowledge about their land, the added value of analysing soil samples will be limited. This is an institutional problem. Therefore we need to develop a system in which the land is used by the same farmers, growing crops in blocks.

With respect to accreditation, international cooperation is needed.

Organic farming is practice on 80% of the area, but we lack a national certification system. This will be very expensive. Furthermore enhancing organic farming and enhancing commercial farming will be contradictory.

5.3 Report interview mr. Isaac and Machavela – AgDevCo (BAGC)

BACG aims to bring all stakeholders in the Beira Corridor to enhance commercial agriculture. It has a fund to finance public goods supporting smallholders. AgDevCo has a budget of M20 dollar to support SME's, agriculture business, commercial business. We focus on the investments. We made about 12 investments. Some in maize, soybean, and sesame, others in poultry and other livestock. Some in fruits such as bananas, peach, mango, and also in honey. The potential is there and we see rapid developments. We don't have expertise in soil labs, but we have experience in similar projects. We can finance this project if it can be shown that it will be profitable in the long and if also public money is available to support initial investments. My gut feeling is that it will be not profitable in the coming 5 years because of the low volumes of soil samples. So we need a PPP in which very clear rules are defined for the management structure, and who pays for which activity.

Joop explains that it can be a business model to include the advisory sector. We need the laboratory for knowledge development which is a public function. We also explain that the focus is on soil lab services rather than on the soil lab itself. This enables us to explore routes in which we save money in the beginning and reduce the risk of wrong investments.

Lead times are important. We ask for advice how to involve the trading companies. The reality is that it is quite difficult. We know one exception providing seed and fertilizers. Furthermore they do not have much interest in a soil lab, although they have interest in product quality. We explain that a next function can be testing plant tissue on contamination which is more to their interest.

Private commitment does not necessarily mean private money. It can also be arranged by inviting them in a steering committee. Especially in Mozambique we have a long history in NGO-projects ending in nothing. We explain that because of this reason, private involvement is necessary. In the short run, the lab delivers public goods (generic guidelines for fertilizer application). In the long run it serves private interest, showing the fertility of specific parcels, fine-tuning the information, managed for a long term by the same farm.

AGRA has also resources for this type of projects. BACG has an office in Chimoio.

Do you see ethical risks such as land grabbing etc.? No, I don't see many risks for this. There will be big investors making much money. But farmers will have net profit from this development. From the market side, breweries can be added. They need quality analysis of the products. So the number of analyses can be expanded.

Output based aid GPOPE (World Bank Group), PIDG: public subsidies for results: payments for performance such as a minimum number of samples: an accelerating instrument.

5.4 Report interview mr. Eric Schmidt, IFDC

Joop explains the objectives of the mission. There is both public and private interest. We start to look for possibilities to start soil lab services. In Maputo we have skilled people, but the equipment is partly broken. On the other hand, Omnia has large lab in South Africa which can analyse a huge number of soil samples for a low price. We are looking for a model how it can be made successful. We know that there will be substantial demand for lab services in the future, but the question is how to get there. A soil analysis is not enough; it needs to be combined with an advisory sector.

Soil information in this country is lacking. The scale of current soil map is too big and doesn't provide good information. Information management is too weak. No incentive, low pay and people go to other opportunity. Fertilizer use is constrained for the market. The most popular fertilizer is 12:24:12. There are other fertilizer options elsewhere such as LAN. Need to build good fertilizer recommendation. This work could be done by IIAM. Most of farmers use fertilizer for vegetable not for maize.

It is important to have a lab with capacity to do more things such as aflatoxin.

Eric explains that Jan Huesken asked him three months ago, and I said no. We have to distinguish between a lab serving research and a lab for commercial purposes. I lived in South Africa for a long term. You must consider the price. Farmers don't pay a price if they can get it for 50% of that price. At present we do not provide proper advices to subsistence farmers. We train agro dealers. My recommendation is analyse water, phyto and plant tissue.

Some investments are not being used. There is seed cleaning facility in Nampula which is not being used properly.

Consider the connections with South Africa for training. These are very open. South Africa has made considerable scientific progress.

When setting a lab it is important to have individuals with skills on management, not only technical.

Involve commercial people from Omnia, Greenbelt etc. AGRA has demonstration project for application of N,P and K. BACG is a good initiative. Consider combination with a vet lab. Ask for public money from the Mozambican government. They have money, and it will generate revenues. Involve universities of SA. Extension services are not very productive.

Start with generic recommendations for fertilizer application for each region. Teach young people not only technical skills but also how to manage a lab.

Agro dealers can play a central role in collecting samples and providing advice. Services can also be used abroad (Malawi etc.)

Look also to GTZ (Germany), USAID, FAO how they support soil lab facilities. Learn from each other.

Annex 6 Interview of Friday June 29

6.1 Report interview dr. David Mariote, Eduardo Mulima and Miguel Magalhaes – Centro Zonale IIAM Chimoio

Joop explains the objectives of the project. We have started with a lab for soil analysis. We think that it should be combined with an advisory service. Intended customers are commercial farmers and with the help of the advisory services subsistence farmers.

Dr. Mariote explains that good soil analysis is important. We have a university (research and teaching) (ISPM) who could use the facility for teaching. We are doing soil fertility research work but without soil lab. This need was presented to the ministry of agriculture. If we have this, we can solve a lot of problems. We have contacts with the ministry of Agriculture to get budget. The region is very fertile and has high agricultural potential. We have the conviction that private farmers want to pay for soil analysis. Some samples are sent to Maputo or Harare. The price is currently too high for most of the farmers. That's why they ask us to develop a soil lab. It is recommended combining the use of the soil lab with ISPM who wants to use the lab for education purposes. Some of the colleagues at IIAM in Chimoio have skills in analysing samples but additional training is needed. However, the results of commercial and research samples need to be accurate. Students need to see differences, rather than exact answers.

Is IIAM involved in the Beira Corridor development? Yes. We have the idea to make the management of the soil lab both public and private. Joop answers that we have the vision that we start with a public. This serves also research and extension purposes. When the number of soil samples grow, it will become less interesting for public parties and more for private partners. It is important to react quickly. It is important to make it sustainable. It cannot be financially sustainable from the beginning.

Colleagues can be sent to Maputo for training in lab skills. It is important that revenues of lab services can be used for reinvestments.

We have a project financed by AGRA to shift subsistence farmers to commercial farming. We already see an increase of production and they are searching for clients buying their products. Do you expect that farmers will pay for services which are currently free? We don't think so at this moment. Maybe in future when they understand the value of soil sampling analysis serving the level and quality of products.

The best place is Sussundenga, although we need some adjustment to the water supply: reparation and cleaning. We need to assess whether the volume is sufficient. In Sussundenga, a number of services are already present. Farmers know the place and come for advice. Chimoio is also a realistic option.

Do you also see the need for aflatoxin analysis? In Nampula, we have already the facilities, but we see not very much demand for that kind of analysis. It can also be part of the extension services to prevent commodities being contaminated with aflatoxins.

We are your expectations for the shift towards commercial farming 5 years from now?

Pessimistic: 25%, 20%, 20%

Optimistic: 50%, 60%

Realistic: 40%, 50%

Agro dealers are important. They are supplied with seed by seed suppliers, but also provide pesticides and fertilizers. They can be educated to take soil samples.

Is the government willing to invest in a PPP for establishment of a soil lab? I think yes. The question is if they have the money. In other elements they give their support.

6.2 Report demonstration by dr. Rafael Massinga, ISPM

Dr. Massinga gave us a demonstration on the future campus. A number of new buildings for college rooms, library, administration etc. are realized. Some other buildings are refurbished. One of these buildings is

prepared to accommodate laboratories for soil analysis and plant health analysis. The whole project is co-funded by Kuwait funds and government of Mozambique. The priority is to educate students at BSc-level. Students come from all over the country. Most of them have an agricultural background. The second priority is to serve research. Students can be involved by taking samples from their home, analysing them and write a fertilizer advice to take back. The third priority is to analyse soil samples commercially. The additional capacity of the labs can be used for testing soil and plant samples of commercial farmers. The revenues can be used for reinvestments in and maintenance of the laboratories.

Combination of three objectives (education, research and commercial application) of a soil lab has been discussed. We come to the conclusion that this is not advisable to combine all the functions into one lab serving the whole Beira Corridor region. The reasons are that students need to train techniques. The equipment needed for this purpose is not necessarily the same as for commercial practices and research. Furthermore intended accreditation for research and commercial purposes does not go together with use of equipment by students.

Suggestions were given on setting the lab for easy sample handling minimizing contamination and to reduce the risk.

6.3 Report interview IAC by Marcus Carlos, Pompilio Margues and Mufuessuane

Ricardo introduces the project and the interviews and visits we had until now. The IAC has a lot of experience in training. The problem is that most of the equipment has been imported from Russia. After the collapse, most equipment could not be maintained. In the training course it is described to take samples and to analyse them. They are not able to do so. So IAC needs an education facility. In the past farmers from the region used to come to IAC requesting soil analyses. Currently most of them send their samples to Harare, Zimbabwe afterwards.

It is beneficial that farmers seem to trust IAC. That is a positive signal for establishing a soil lab in this region. In the class they say that you need to know the fertility of the soil before you apply fertilizers. It can be solved by teach the students to take samples, to send them to a lab and to visit the lab to see how these samples are analysed.

IIAC has experience of PPP kind of model which was not positive. The institution has production and training. The production component grows into business and the training component of the production unit was overlooked. They are working on improving this model to ensure that linkage between production and training is not jeopardised.

They have a lot of equipment sent to them by the ministry of education, which is superfluous, because it does not fit in their curriculum. At IAC also people are trained on technical skills. They want to establish labs analysing products, milk, plant diseases etc. The lab to be re-established will not only be used for training but also will for commercial purpose.

Study have shown that students trained in Mozambique lack technical skills when compared with other countries in the region (SADC), therefore the government through PIREP intend to improve training capacity by revising curriculum and providing necessary tools.

Because recognized capacity of IAC it is currently conducting season long training of private extension of Mozambique leaf Tabaco, a private company.

We think that it is necessary to set priorities consistent with your mission: educating young people at secondary technical school level. This requires a relationship with a lab, without application of advanced lab techniques, which can be demonstrated by visiting a professional lab.

The IAC became more business oriented. A successful private lab is also important for IAC, because they have to educate extension workers and commercial farmers.

The ministry of education is currently rethinking curricula of schools in order to make them more demand-driven.

Annex 7 Interview of Saturday June 30

7.1 Report interview Augusto Jaime – Vanduzi company

Vanduzi produces fresh fruits and vegetables, and exports to mainly UK, on 450 ha irrigated land. They have all necessary certificates in order to keep the position on the market. Soil samples have to be sent to South Africa. We have tested the reliability of soil analysis in Zimbabwe. Although certified, it turned out to be not reliable. The lab in South Africa we trust. The lab is also certified, which is important for exports. Tissue analysis is a dream. We need phytosanitary certificates to send it abroad for testing. For fresh products it does not work. Soil samples also need clearance to prove that we are not exporting minerals. The lead time for taking soil samples until the results are received is two weeks. We send 26 samples each month, not only from soil, but also from compost. The price is 77 US dollar lab costs. The analysis will only be good for the next crop. Most farmers don't farm properly because they are guessing.

We explain that a PPP will be important for establishing a lab which can be trusted. I have to calculate the amount and composition of the fertilizer to be applied on the base of the soil sample results.

There is some cooperation with other commercial farmers in which we talk about daily matters: market developments etc. (Fruit Centre). Vanduzi Company has also contracted smallholders. We provide seeds, inputs, technical support and agree fixed prices. The only risk is the volume of the product. We intend that they become independent. Some of them show potential. It is important that they pay prices for inputs.

The biggest thing is demand for products, which is present, but has to be developed.

The short term solution is to continue analysing soil samples in South Africa. In the mid and long term we need a lab here. Private investments from commercial farmers in setting up a lab can be discussed, but that also implies that they are involved in the decision making process.

Augusto shows us an example of soil analysis results. We discussed the involvement of fertilizer industry.

Augusto doesn't trust the results. They want to sell fertilizers. Don't trust fertilizer industry. A lab must be independent. We have even to check whether the product specification of the fertilizer is correct.

7.2 Report interview Kevin Gifford – Phoenix Seeds, Forbes Walker - University of Tennessee

Phoenix seeds is a company cultivating 460 ha in the neighbourhood of Vanduzi. Soils samples are analysed in Harare and cost 25\$ per sample. In Mozambique, we lack sufficient knowledge about the soil sample.

Two approaches can be used for fertilizer advice based on soil samples:

- Sufficiency approach: what is needed for the crop?
- Maintenance approach: what is necessary to maintain the original level of elements in the soil?

The first approach is mostly followed by independent institutes; the second by the fertilizer industry. Some elements always flush away and have to be added.

Extension can be organized by satellite groups of frontrunners applying new results together with farmers unions.

Fertilizers need to be applied for sustainable agriculture. Otherwise the soil will be depleted and erosion will follow.

A good location is Chimoio, because an airport is nearby. Fertilizer industry can be asked to accommodate the lab.

Annex 8 Interview and feedback meeting of Monday July 2

8.1 Report interview Eduardo Mulima – Centro Zonale IIAM Sussundenga

The IIAM research centre in Sussundenga is doing research mainly on crops, and some animal husbandry (cows). It is coordinating the research on maize. It has about 50 ha for trials. It is also breeding maize and producing seed for seed companies, which can produce certified seeds.

We intend to keep the research station into a good shape. We have irrigation system (sprinklers), although we are not able to irrigate every field, because of limitation of the capacity.

Have a lab here; we will have a problem with transport. Most scientific researchers live in Chimoio. About 10 scientists are working in Sussundenga, 15 technicians and 70 workers. If the lab should be located in Sussundenga, technicians should live here. The road can also be used during summer when there is more rainfall. They intend to pave the main road maybe next year.

There are commercial farms around Sussundenga. They send their soil samples to Harare. Near the research station they have about 20 ha.

The soil samples are analysed on pH, N, P, K and macro-nutrients. Our soil samples are analysed in Maputo (around 100 a year).

Having a lab in Chimoio is almost the same as in Sussundenga. Having a number of simple soil measuring instruments will be sufficient (pH-meter, EC-meter). Calibration of instruments should be frequently being executed.

8.2 Report Feedback meeting BACG – Chimoio

15 stakeholders are present

Joop, Ricardo and Johan present the intermediate results reached so far. The following remarks and recommendations are made:

Some discussion arises about the increase of the area cultivated commercially. Some attendants think that it is too optimistic. However, we have estimated the necessary capacity conservatively.

Is the lab also able to analyse soil samples from other origin and looking for different minerals (e.g. mining industry)? Yes, this is an additional option.

1. Intertek is also developing an idea about a soil and plant tissue lab. Monopoly?
2. Plant pests and diseases (testing, pest control, phytosanitary control) are also involved?
3. How to get smallholders involved? We have to investigate.
4. Risks of the investment and the market have to be discussed.
5. How competitive is the 25\$ price?
6. Requirements for establishing a reference lab at IIAM in Maputo?
7. Interpretation of sample results linked to the lab is necessary on behalf of extension workers.

1. You have to be aware that involvement of private firms can set up a monopoly deciding by their own which lab service they will provide and which not. This can be prevented by developing a set of conditions before private firms are invited to participate or own the lab. Furthermore, a board of independent directors can be established. Private firms can also change the methods.

2. We don't want to include everything. It will be added to the list. Aflatoxins are important, especially for peanut industry. It can be done with different instruments. Technicians need to be trained to use these instruments. It can be difficult to leave soil samples at the new lab and send other samples to other labs.

There is also a risk of doing too little and not only of doing too much. There are donors available filling the financial gap.

3. Establishing the lab has to serve the smallholders shifting towards commercial farming. One way is to organize the farmers in associations. To our ideas it is not a good idea to subsidize lab services and provide them for free. Smallholders should be aware that a good advice about the soil fertility and fertilizer application costs money which can be earned back by higher production value. Extension can also be subsidized on behalf of smallholders. An idea is to focus on specific value chains, such as peanuts. There is a growing demand for peanuts which create a pressure to use soil analysis and fertilizer use. Another model is contracting smallholders by commercial farmers. They provide input (seed, fertilizer, soil samples) which costs are deducted from the production value.

4. Yes, we will include this in the final report.

5. Prices vary between 25 and 35\$. Revenues should be at the disposal of the lab!

6. There is a program of rehabilitation and an education programme.

7. This is an opportunity for ISPM, IAC and IIAM.

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Annex 9 Interview of Tuesday July 3

9.1 Dr. Amimo, Provincial director of agriculture – Manica

The team had a brief meeting with provincial director of agriculture of Manica in the airport.

The team briefed the objective of the mission, contacts established in Maputo prior to travel to Chimoio, and meetings held in Chimoio. The provincial director welcomes the idea of setting soil and plant tissue laboratory in Manica. We believes it will contribute to agriculture development in the region because currently farmers apply fertilizer without information on fertilization needs. He expects positive outcome of the mission.

9.2 Report interview Rebbie Harawa – Agra

Joop explains the results of the project until now, including the feedback meeting with stakeholders. Rebbie has a number of questions which have been answered by the team:

- Who will be the owner? This is not to be decided by the team. The project results have in our opinion to be adopted by the BAGC. The future owner will be private, but has to ensure that public responsibilities will be maintained.
- Are you aware that a lab does not only require investments, but also maintenance and skilled staff? Yes, we are very aware of this. We have made a number of recommendation such as education of staff at the laboratory in Maputo (IIAM) and the necessity to use revenues for maintenance of equipment. IIAM has to train the staff and provide internships.
- AGRA-SHP did an assessment of IIAM central lab needs couple years ago. AGRA-SHP has initiative on fertilizer quality control through which may include soil analyses.
- Kenya has a number of private companies providing lab services.
- Things done should be mapped out.

Does Agra have interest in this initiative? Agra is already supporting three projects of IIAM on soil analysis. We are willing to support this initiative and need a well-functioning lab. AGRA-SHP does not have additional funding for supporting establishment of a soil lab but welcomes the idea. Soil analyses could be done in this lab for improved fertilizer use.

AGRA-SHP investment in equipment goes to training institutions because they have training program with some Universities.

Private sector working in out grower scheme with smallholder farmers could use this facility to ensure good quality of the product.

Private lab could be an alternative. Some private lab not only provides services but also produce inoculants for sale.

It was requested time horizon that investment will stay and who will manage the lab. Substantial investments were made in Africa but few labs are functional due to lack of trained personal, inadequate maintenance.

It is decided that Rebbie will receive the presentation of the feedback meeting in Chimoio and the report. She will be asked to comment on both.

Annex 10 Validation findings with experts and resource persons. Dutch Embassy Maputo Wednesday July 4

The MoA wants to know if the study addresses government request to the Government of the Netherland which was to have a soil and plant tissue laboratory in central Mozambique.

IIAM recognizes the challenges that such investment would bring in terms of managements given the fact that primary objective of IIAM is research, and lack of pre-conditions at IIAM to accommodate such initiative in short term. IIAM is aware of the challenges that existing public laboratory are facing and efforts are being made to make those lab functional and provide support for good research and quality serves such as the investment in pipeline supported by Embrapa.

There is shifting from public supported commercial lab to private initiative in the region. However, it is important to recognize specificities in context of Mozambique.

There is risk that public interest will not be safeguarded if fully private lab exists in the region.

There is already strong private interest in investing in soil and plant tissue in the central Mozambique because they already show the demand for services. It is discussed that research also has interest in the data supplied by the lab (e.g. mapping and development of soil quality. Also methods used by the lab should be related with the methods in use in Mozambique.

General conclusions:

There is consensus that Public Private Partnership as way to go in the moment and further discussion needs to exist for details of the model. The team should elaborate more on the following issues:

- ☐ What kind of issues needs to be discussed on PPP MODEL
- ☐ Who will be the owner of lab in short and long time
- ☐ Suggestion: Because government will put public funds, human capital, and other facilitations so the government should be the owner of the investment
- ☐ How phasing out will be implemented. The principle of Building Operation Transferee needs to be discussed (BOT).
- ☐ What mechanisms should be in place in order to the lab implement commercial price while supporting small-scale farmer who cannot afford commercial price?
- ☐ What strategies needs to be in place in order to build the demand
- ☐ How extension services needs to be organized for better serve small-holder farmers and at same time create the demand for lab service
- ☐ Possibilities to use produced data, taking into account privacy of farmers

Other information:

The government is making every effort to move from small-scale farmers to medium-scale farmers. The government should continue to have a role in the investment in short and long term.

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Annex 11 Interview of Thursday, July 5

11. Report Interview Mr. Dawie du Plessis, Intertek

Intertek is a big company with vast experience on laboratories. They have expertise in different areas. It is business oriented but with social responsibility.

Mr. Dawie is working in Mozambique for past 11-12 years. They are working on mining industry, petroleum, agriculture. They are concentrated in South Africa. The key areas of the company are laboratories for testing several materials in the petroleum, agriculture, electricity. Intertek is working for setting a lab in Beira that will be capable of testing agricultural products with much higher capacity than the Intertek's lab in Maputo. The lab will be operational in September. The company has big lab in South Africa for soil testing.

There is plan for supporting ISPM for setting lab at ISPM campus but there is concern about sustainability of such lab. There is about \$75,000 (USAID) available for equipment. The consensus has not been reach yet but he believes that could be an opportunity for Intertek because the company would have well trained people who could work for Intertek in the future as they expand the business in Mozambique. Sometime it is difficult to negotiate with the government.

The ISPM lab may be able to do few analyses, but expertise would be needed for ISPM to be able provide fertilizer recommendations to farmers. INTERTAK is planning to get some equipment for key analyses. PPP model may be good but fears conflict of interest (political interference, individual goal, institution priorities, etc.).

Welcome the idea of PPP but doesn't believe that in short term would be return of the investment. Agriculture has potential to grow in this country but good policies are needed to attract investment.

The large farmers could work with small-scale farmers in out grower scheme. The spill-over effect could go to smallholder farmers.

Intertek is working on precision farming. In Mozambique they are looking developing fertilizer requirement maps and make it available to farmer for decision making on how much fertilizer to apply. Currently they are investing 2 million dollars in Tete in coal lab. There is no problem for Intertek point of view contributing to education. There no problem having students getting experience. For coal lab students will participate in the analyses as part of training.

Joint venture with ISPM in soil lab appears not to be the right way to go at the moment. It may need further discussions. Intertek is planning to invest 150,000 – 200,000 in soil lab for some soil analysis and provide recommendations. A team from SA would provide appropriate fertilizer recommendations. They are also interested in environmental analyses such as water quality and pesticides.

Intertek is willing to partner with other institutions to put better thing. This is right time to make such investment and benefits will come later. If Intertek could have soft funds could put better thing.

There are some challenges for putting laboratory at UNILURIO, but things are not moving at speed that should move. It may need further discussions to put things on track.

PPP could be set but and needs to be business oriented to ensure sustainability of the investment. Clear role, responsibilities and shares needs to be included on the MoU. Also the lab could support colleges for additional training. If private sector is not involved the sustainability of such lab will be compromised. Current trend of agricultural development in Mozambique will create more demand for lab services in the future. The plan is to have a company which will be responsible for providing recommendations to the farmers. It will be education side of the company. There is agricultural potential in Mozambique to be exploited. Intertek is open to PPP for the benefit of this country.

Estimated to invest 150,000 – 200,000 next year. But the location still needs to be identified. Possibly in Beira or Chimoio. Normally they prefer putting investments in same location to share infra-structure, personal, etc.

Annex 12 List of participants involved in this project

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Dr. Serafina Manguana - National Director for Agricultural Services
Dr. Inacio Maposse (General Director), Dr. Calisto Bias, Dr. Manuel Amane, Dr. Nurbibi Cossa, Dr. Suzie Aline Aly - Institute of Agricultural Research of Mozambique (IIAM)
Eric Schmidt - Country Director International Fertilizer Center (IFDC)
Dr. Antonieta Nhamusso- Platform for Agrarian Research and Technologic Innovation (PIAT),
Dr. Argent Chuula - Country Representative of the Alliance for Green Revolution in Agrarian (AGRA),
Mr. Abdul Mussuale, Mr. Lasoro Augusto Nhangombe - Center for Promotion of Commercial Agriculture (CEPAGRI)
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Mr. Augusto Jaime – Senior Agronomist Vanduzi Company
Mr. Philip Venter – Director Mozambique Fertilizer Company
Mr. Monty Hunter, Mrs Danielle Conde – RDI
Mr. Kevin M. Gifford – Director Phoenix Seeds
Mr. Dawie du Plessis – Intertek
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