Subcontract Agreement for the Execution of USAID/SADC/SARRNET Grant No. 690-G-00-99-00258-00 between the International Institute for Tropical Agriculture, IITA, and the International Center for Tropical Agriculture, CIAT

II Report
Period June 2001 to May 2002
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II Report
Period June 2001 to May 2002

Presented by: the International Center for Tropical Agriculture, CIAT

Presented to: the International Institute for Tropical Agriculture, IITA

July, 2002
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1.0. Introduction

The Southern African Root Research Network (SARRNET) seeks to increase income and improve the welfare of the rural poor by increasing small farmer cassava and sweet potato productivity through:

- the adoption of improved varieties and practices,
- the strengthening of national root crops research capabilities, and
- commercialisation to increase added value to the crops.

The subcontract agreement between the International Institute of Tropical Agriculture (IITA) and the International Center for Tropical Agriculture (CIAT) is to provide professional and other related services to meet the overall objective of SARRNET, described above. CIAT will provide these services through its membership of the Latin American Consortium for Cassava Research and Development (CLAYUCA) and its own Rural Agroenterprises Development Project. These services will contribute to achieving the specific objectives of the following four Theme areas:

Theme I: Establish of a private–public consortium to support research and development of sweet potato and cassava in at least one country.

Theme II: Detailed understanding of the subsector and marketing opportunities to increase awareness among stakeholders of potential opportunities for the crops in the region.

Theme III: Sustainable and appropriate processing technologies adopted by farmers and industrial processors.

Theme IV: Stakeholders trained in new skills to support the market driven strategy at regional level.

2.0. Report on activities undertaken in the period June 2001–May 2002

Following the activities included in the work plan developed for implementation of the subcontract agreement between IITA and CIAT, some interventions of the CIAT and CLAYUCA personnel were realised during the period covered in this report (Table 1). Based on the results obtained in these activities, a brief description is given in each of the themes included in the work plan, with explanations of where some adjustments have been made of the original objectives envisioned.

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In November 2001, during the visit realised by CIAT and CLAYUCA personnel to the project region, a critical review and evaluation was made of the advances and results obtained and the constraints affecting implementation were identified. In general, the consultancy team observed important advances in Tanzania and Malawi towards the process of building closer linkages and mutual trust with the private sector.

Each of the four themes that were initially included in the work plan was analysed. Emphasis was put on identifying those activities that could and would be realistically achieved during the remaining months of the project. As a result, some activities were eliminated and others were adjusted given the limited time available up to the end of SARRNET Phase II (September, 2002). In the cases in which new partners were identified and joint activities initiated, a description is made of the activities using the same format presented in the first report. The adjusted work plan is presented in section 3.0.

In May 2002, a new visit was made by CLAYUCA personnel to Tanzania and Malawi, during which an assessment was made of the advances obtained and the constraints that are affecting the implementation of the work plan. Although it is still soon to draw definitive conclusions and recommendations about the work that has been implemented during the last two years, some of the results obtained can be summarized as follows:
2.1. Tanzania

2.1.1. Private sector contacts

A total of 32 industries were visited during the first round of the market surveys. This group of potential stakeholders/collaborators for SARRNET comprises:

- 9 animal feed millers
- 4 breweries
- 5 biscuit manufacturers
- 9 bread-making industries
- 2 flour industries (for human consumption)
- 1 chemical industry
- 1 textile industry
- 1 food inspection industry

The second round of visits and contacts was limited to 4 feed millers selected as those showing greater potential. Some activities were planned with these contacts and the initial results are reported in this document. Recently, SARRNET team in Tanzania has identified new contacts and new activities have been initiated. These activities are also included in this report.

2.1.2. Potential markets for cassava in Tanzania

The main commercialisation outlet for cassava in Tanzania is the fresh market. This can be confirmed by revising some of the main studies that have been conducted in the past. One of the most complete studies about the importance of the cassava crop in Tanzania was prepared as one of the country case studies selected for the Global Cassava Development Strategy implemented by IFAD in collaboration with FAO. In this study, several papers are mentioned related to other studies that have been conducted in the past to try to understand the main characteristics, trends and potential of cassava markets in Tanzania. Some of the main findings of these studies can be summarized as follows:

- Fresh cassava trading is characterised by having a large number of small scale traders scattered all over the marketing chain
- Limited transport and storage facilities makes access to market a serious problem forcing farmers to sell the crop at nearby market mainly at reduced prices, despite the fact that there are local and external markets available

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3 Msabaha M.A.M. National Agricultural research Masterplan: Cassava, a crop reviewed. Ministry of Agriculture. Livestock Department. Tanzania. 28 p
Cash income from cassava production was higher in villages that had easy access to markets or to production credit. Farmers who had easy access to market earned more cash because they had greater access to market demands for the products. Also, the same farmers earned more cash because they had greater access to supply of inputs, which enabled them to expand production.

The use of improved post-harvest handling facilities expanded market demand because it improved product quality. Quality processed cassava products are more convenient to urban consumers and are more competitive with food grains in the market.

More recently, as part of SARRNET activities in Tanzania, a research activity was conducted to collect information that would enable an understanding of the structure and performance of cassava and sweet potato marketing in Tanzania. Some of the major conclusions of this activity are as follows:

- Cassava is one of the staple foods in the surveyed regions but more popular in the rural areas of Coastal regions of Dar es Salaam.
- Major supplies of cassava to consumption areas do not move very long distances.
- Commercial producers of cassava are found therefore at production sites near to markets compared to sweet potatoes.
- Sweet potato and cassava are marketed mainly by small scale traders.
- Both cassava and sweet potato seem to be more supply driven than demand driven except for the period of the Ramadan during which they become a very preferred crop.
- From the traders’ perspective, transportation is the major constraint to marketing. Poor and inaccessible roads and long distance to large markets lead to high costs and reduce the surplus and market margins.

The options for SARRNET intervention in this market could include enhancing and strengthening the release and distribution of improved varieties and the promotion and dissemination of sustainable soil and crop management practices. Other area that can be considered is the organisation of farmer groups so that their participation and bargaining power in the commercialisation channels is improved.

The second most important market appears to be the market for cassava flour for human consumption. SARRNET's potential to make an impact in this market is very promising. The introduction of chipping and drying technology, combined with sound production practices, could help farmers to establish and consolidate a market channel based on price competitive, high quality cassava flour. Currently farmers produce (semi) fermented cassava flour of low quality. There is a high demand for high quality chips. The fact that cassava flour is easier to store and market, facilitates the creation of links of the farmers.

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with urban markets. For SARRNET this intervention could be the one of the most appealing strategies in the short term. Currently there is a good demand for the chippers and the interest shown by farmers in the region in which some activities have been initiated with the concept of pilot project, could facilitate the dissemination of this strategy in some of the main cassava production areas of Tanzania. These pilot activities are presented in other section of this report.

The third market option is the animal feed sector especially for the dairy and poultry sectors. Dried cassava chips and flour can be promoted as an ingredient that could replace some portion of the maize that is currently used in balanced feeds. The animal feed trials that are planned will hopefully generate results that can be used to convince and attract the feed millers and the poultry and dairy sectors. Once the pilot site starts working full scale, and cassava roots and leaves flour are produced at competitive prices, the linkage of farmers with these markets could be more easily achieved. SARRNET’s intervention must emphasis the dissemination of the chipping and drying technology, the development of a combined chopper-chipper for leaves and roots and the installation of improved crop production trials at the pilot sites.

The dairy sector in Tanzania could become a very important market for cassava. According to comments made by two dairy producers that are collaborating with SARRNET, the demand for milk products is growing steadily in this country. The use of cassava roots and leaves through silage technology might be a good opportunity. Initial yield results of intensive cassava leaves and roots trials are very promising. Some collaborators in the dairy sector are already very interested in this option and have started planting cassava fields for both, root and leaves production. What needs to be done is to conduct feed trials with dairy cows to test and promote the idea.

2.2. Malawi

2.2.1. Private sector contacts

A total of 12 industries were visited during the first round of the market surveys. This group of potential stakeholders/collaborators for SARRNET included:

- 1 Brewery industry
- 1 Textile industry
- 1 Plywood industry
- 1 Packaging industry
- 3 Feed Millers industries
- 1 Bakery industry
- 1 Biscuit manufacture industry
- 1 Dairy industry
- 1 Farmers association
During the second round of visits to industries and potential collaborators in Malawi, a total of nine industries were contacted and some concrete activities were initiated with some of them. The initial results of these activities are covered in this report. Recently, SARRNET team in Malawi has identified new contacts and new activities have been initiated. These activities are also included in this report.

2.2.2. Potential markets for cassava in Malawi

Malawi’s agricultural sector is dominated by maize and coffee. Maize production has been severely affected in recent years due to factors such as floods, droughts, high cost of imported inorganic fertilizers and declining soil fertility. Maize is the country’s main staple food and any inadequate production enhances chronic household food insecurity.

“Cassava and sweet potato have been for many years considered as a “poor man’s crops”, playing a minor role in the food economy of Malawi. However, because of the declining maize productivity resulting from declines in soil fertility, inability of most smallholder farmers to manage their soil fertility due to lack of cash income and credit facility as well as persistent drought in the region, serious efforts are now been made to diversifying food production away from maize. Progressively, cassava and sweet potato have become important crops in terms of area under production and their contribution to food security.”

“Cassava production increased from near 129,000 metric tons in 1992 to near 896,000 metric tons in 1999 (an annual average rate of increase of 85%).”

This year, particularly, it is feared that the food crisis will be of proportions unknown before. There are already several emergency operations being worked out by Government, donors, NGOs and the civil society. This situation has created a direct impact on cassava availability and prices as cassava is used as food security crop. Current levels of production of cassava in Malawi seem to be below demand especially the increasing requests by the industrial sector. Under the current circumstances, with the prevailing levels of cassava productivity and production, the introduction and development of new markets will be more difficult due to the strong competition of these alternative markets with the fresh cassava market that is affected by the current shortage of maize. The strategy to be followed needs to be associated with an effort to generate surplus of cassava.

This implies two options for SARRNET:

- Dissemination of improved crop production practices (seeds, fertiliser, pest and disease control).

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8 Akoroda, M.O. and Mwabumba, M.L. 2000. Adoption rate and impact assessment study of the program for accelerated multiplication and distribution of improved cassava planting materials in Lilongwe East Rural Development project.
- Link up to medium/large scale commercial growers to generate surplus of cassava.

Similar to the situation in Tanzania, the main outlet for cassava in Malawi is the fresh market. For SARRNET, the main intervention in this market could include the activities that are currently implemented regarding the introduction and promotion of improved varieties and good crop husbandry practices, complemented with actions aimed at improving the organizational levels and the bargaining power of the farmer groups with which the network is working directly. There has already been achieved a great impact, in the regions in which improved cassava planting material has been distributed, considering the enthusiasm and dedication that farmers are showing with the cassava fields. This strategy should be maintained and strengthened.

The second important market is cassava flour for human consumption. There is an increasing industrial demand for good quality cassava chips in the biscuit industry. Cassava flour is currently included in levels around 20% in the production of biscuits. The quality of the chips in very variable and sometimes the only chips available are those known as *makaka* in the local language. These chips are produced through drying of whole roots. It usually takes four to five days to dry and the final user at the biscuit industry needs to rasp them to get rid of the outer layer usually affected by insect biting. The introduction of the chipping and drying technology by SARRNET has aroused a lot of interest by these users, which are in favour of the better quality of the chips as compared with *makaka*. What follows now for SARRNET in this market is to strengthen the work at the pilot site, organize the first group of farmers to adopt the chipping and drying technology, generate good quality cassava chips and use them to establish the link with one of the industries that have shown interest. The demonstration effects of this work could help to disseminate the strategy around other cassava producing regions in Malawi.

The third market is the animal feed sector, both for poultry and dairy. Livestock nutrition is one of the major challenges in Malawi. Maize is used as the principal energy and protein basis for animal feed. With the current crisis of maize, providing a balanced feed to poultry and dairy sector using maize as the energy source has become problematic and very expensive. Moreover, the animal feed industry does not have an alternative energy source to cope with this situation. Therefore, the potential of using cassava as a sustainable, price-competitive energy source for the poultry and dairy sector has become attractive. In this regard, the current work of SARRNET with Land O’ Lakes could prove to be very strategic to position cassava as a sound technological option for animal feeding (dairy sector) in Malawi. For the poultry sector, the work in progress with Universal Industries offers a great potential to enhance the consolidation of cassava in animal feeding. This industry conducted its own feed market assessment study and concluded that the feed requirements for the animal production sector in Malawi is of about 10,000 tons per month. They are also negotiating a project proposal with a foreign donor to establish a cassava processing plant (cassava flour for animal feed). If cassava can be positioned in this market, it could mean a great push for increased demand of the crop by the industrial sector. SARRNET should maintain and strengthen its collaboration with this industry and other interested partners in the private sector.
Other potential markets for cassava in Malawi are starch and glues but the size of the markets in these sectors appears to be very small.

3.0. Work plan: An updated version

After modifications and adjustments made by SARRNET teams in Malawi and Tanzania, the current version of the work plan is presented in section 3.1.
3.1. Theme 1: Establish of a private–public consortium to support research and development of sweet potato and cassava in at least one country.

Activity 1. Participation in cassava/sweet potato workshop (SARRNET/Bunda College, Malawi).

- This activity was realised in May 21–23, 2001.
- CIAT/CLAYUCA personnel did not attend.
- The main achievement for SARRNET was to gain recognition as a “technology clearing house” for cassava and sweet potato production and processing technologies.
- SARRNET Malawi team has elaborated a database on the workshop that includes: a list of participants, pictures, video and the proceedings.

Activity 2. Contacts with Malawian industries identified as having interest in using cassava/sweet potato products.

- During the first visit to and contacts with Malawian industries interested in cassava and sweet potato, a significant number of cassava farmers, processors, machinery manufacturers and current and potential users of cassava and sweet potato were identified (IITA, 2000).
- In 2001, a second visit was paid to a selected group of industries and follow-up activities were planned. The SARRNET Malawi team was responsible for monitoring these activities and providing logistical support.
- In 2002, a third visit to Malawi by the CLAYUCA team was organized. The SARRNET Malawi team was responsible for organizing these activities.
- This report registers the advances found and the revised action plans.

Activity 3. Contacts with current and potential users of cassava and sweet potato products in Tanzania.

- During the Industrial Demand Study realized in Tanzania in 2000 (IITA, 2000), a total of 32 companies were identified as having current and potential interest in cassava and sweet potato. Later, four of these companies agreed to implement joint production and processing activities with logistical support and monitoring given by the SARRNET team in Tanzania and personnel from the Kibaha Agricultural Research Station.
- In 2001, the consultancy mission of CIAT and CLAYUCA visited these industries and a review was made of the results obtained.
- In 2002, the consultancy mission of CLAYUCA established a new contact with these industries and revised the results obtained. New contacts made by the SARRNET team in Malawi were also visited. This report register these activities and includes a revised work plan.
Activity 4. Formulation of the Consortium framework for Malawi and definition of a tentative research and development agenda.

• Results obtained in Malawi, with the activities conducted up to now, have not yet allowed the fulfilment of this objective. Setting up a private–public sector partnership or consortium is a process that will require more discussions with and among potential stakeholders. It is not realistic to expect that this Consortium will be created in Malawi before the end of present phase of SARRNET. However, some of the industries with which the SARRNET team in Malawi has been working during the last two years are already showing a fair degree of commitment towards collaborating with SARRNET (Universal Industries, Land O’ Lakes, Rab Processors) and this aspect could be used to develop some kind of sustainable partnership.

• Conversely, in Tanzania, the results in relation to this objective have been more promising. Contacts with the Tanzanian Animal Feed Millers’ Association have moved forward and the process of establishing a business centre to support this sector is in progress. This activity is covered later in this report.

Activity 5. Preparation of materials in root crop processing (catalogues, prices, layouts, information) for business plan development.

• Based on the identification of potential technological options for industries interested in cassava and sweet potato in Malawi and Tanzania, CIAT and CLAYUCA assembled information on technologies for processing of cassava flour, starch and croquettes, and delivered it to SARRNET teams in both countries as well as directly to some industries interested.

• This information is now available in the form of written documents, power point presentations, videos, pictures and CD room material.

Activity 6. Meeting for launching the Malawian Consortium.

• This activity did not take place during the period covered by this report and more likely will not be conducted during the time remaining of the present phase of SARRNET II. (See Activity 4 above).

Activity 7. Implementation, monitoring and evaluation.

• Monitoring of the activities is conducted on a permanent basis under the responsibility of SARRNET staff at Tanzania (Sicco Kolijn) and Malawi (Vito Sandifolo).

• CIAT and CLAYUCA Consultancy team maintain permanent contact with SARRNET officers in both countries.

• During the period covered by this report, the consultancy team realised two visits to Malawi and Tanzania during which monitoring and evaluation activities were conducted.
### Theme I: Establish a private-public consortium to support research and development of cassava and sweet potato in at least one country (2001–2002)

<table>
<thead>
<tr>
<th>Activity and dates</th>
<th>Participants</th>
<th>Expected output</th>
<th>Indicator(s) for monitoring progress</th>
<th>Pending Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participation in cassava / sweet potato workshop (SARRNET/ARPTU Bunda College) (Workshop was organized late May 2001)</td>
<td>SARRNET Malawi team</td>
<td>Potential partners identified First by-laws drafted Follow-up agenda defined New: SARRNET recognized as a ‘technology clearing house’ for cassava and sweet potato production and processing technologies</td>
<td># Participants Draft document circulated Agenda of the workshop</td>
<td>SARRNET Malawi team to organise a database including: Final list of participants (Addresses) Media coverage &amp; pictures, video, etc.. Proceedings of the workshop. Follow up contacts and impact of the workshop</td>
</tr>
<tr>
<td>2. Contacts with Malawian industries identified as having interest in using cassava/sweet potato products (On-going activity)</td>
<td>SARRNET Team CIAT/CLAYUCA and local private and public partners</td>
<td>Specific interests identified Action plans developed Information on technology options delivered</td>
<td>Document available with potential partners’ characteristic and needs identified and action plans elaborated.</td>
<td>See section 4.1 for updated information</td>
</tr>
<tr>
<td>3. Contacts with Tanzanian industries identified as having interest in using cassava/sweet potato products(^9) (On-going activity)</td>
<td>SARRNET Team CIAT/CLAYUCA and local private and public partners</td>
<td>– Specific interests identified – Action plans developed – Information on technology options delivered</td>
<td>Document available with potential partners’ characteristic and needs identified.</td>
<td>See section 5.1 for updated information</td>
</tr>
</tbody>
</table>

\(^9\) Given the limited time and manpower, activities in Zambia will not be pursued intensively.
**Theme I. Establish a private–public consortium to support research and development of sweet potato and cassava in at least one country 2001–2002 (continuation)**

<table>
<thead>
<tr>
<th>Activity and dates</th>
<th>Participants</th>
<th>Expected output</th>
<th>Indicator(s) for monitoring progress</th>
<th>Pending Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Preparation of materials on root crop processing (catalogues, prices, layouts, information) for business plan development (On-going activity)</td>
<td>SARRNET CIAT/CLAYUCA</td>
<td>Technology options identified according to specific requests and interests expressed by potential partners</td>
<td>List of technologies available according to each potential option</td>
<td>List of technologies documented and available in both SARRNET Offices</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Technology package available for cassava flour for animal feeding, starch and croquettes for human consumption, and silage</td>
<td>Documents available with specifications, prices, capacities, etc</td>
<td>Technology information available in electronic and paper form with specification e.g. prices, capacities, etc</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>To be done by: Sicco Kolijn, Bernardo Ospina, Rupert Best, and Julian Buitrago.</td>
</tr>
<tr>
<td>6. Meeting for launching the Consortium, if needed, in at least one country</td>
<td>SARRNET Team CIAT/CLAYUCA and local private and public partners</td>
<td>At east one consortium established and operating</td>
<td>Official documents like Acts, by laws of the consortium, list of activities/work plan.</td>
<td>Activities will continue to raise awareness about the importance of the consortium approach.</td>
</tr>
<tr>
<td>(On-going activity)</td>
<td></td>
<td></td>
<td></td>
<td>To be done by: SARRNET Teams, CIAT/CLAYUCA</td>
</tr>
<tr>
<td>7. Implementation, Monitoring and Evaluation (On-going, continuous process)</td>
<td>SARRNET Team CIAT/CLAYUCA</td>
<td>Feedback information on project results available Feedback information delivered to stakeholders Make information available through SARRNET Webpage, ROOTS, to stakeholders including SC, partners</td>
<td>Progress reports, annual reports, SARRNET WebPages, ROOTS, special documents prepared.</td>
<td>Create data base with information related to all the activities that are conducted by SARRNET:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>To be done by: Malawi Team: Costa &amp; France Tanzania team: Vianey &amp; Sicco</td>
</tr>
</tbody>
</table>

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10 Potential partners of the private sector are starting to work with SARRNET; Consortium idea will be more feasible later on

11 If activity number 4 proceeds as expected
3.2. Theme II: Detailed understanding of the sub-sector and marketing opportunities to increase awareness among stakeholders of potential opportunities for the crops in the region.

*Activity 1.* Review and analysis of information gathered through literature review to make a preliminary identification of market opportunities in Tanzania and Malawi and Zambia.

- Visits and contacts with industries in Malawi and Tanzania during the last two consultancy trips complemented findings of former visits and contributed to better understanding of potential market opportunities for cassava and sweet potato in both countries.

*Activity 2.* Review and analysis of information gathered through surveys currently being implemented (quantitative data on characterisation of market chain for cassava and sweet potato in Malawi, Tanzania and Zambia).

- The final document of these surveys was received in April 2002 and a preliminary analysis is being done. During the Steering Committee Meeting (Pretoria, May 2002), some of the main messages of these studies started to be discussed. In the future it is expected that they will be used as inputs for formulation of future activities.
**Theme II.** Detailed understanding of the sub-sector and marketing opportunities to increase awareness among stakeholders of potential opportunities for the crops in the region.

<table>
<thead>
<tr>
<th>Activity and dates</th>
<th>Participants</th>
<th>Expected output</th>
<th>Indicator(s) for monitoring progress</th>
<th>Pending Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Review and analysis of information gathered through literature review to make a preliminary identification of market opportunities in Tanzania and Malawi.</td>
<td>SARRNET Team CIAT/CLAYUCA and local private and public partners</td>
<td>Potential market opportunities for each crop identified (done) Preliminary cost structure for each market opportunity elaborated for each country (pending, will be done on the results of the on-going field trials)</td>
<td>List of market options (available) List of cost structure for each option (pending)</td>
<td>Cost structure for each market opportunity needs to be created. To be done by: Malawi Team: Costa &amp; France Tanzania team: Vianey &amp; Sicco CIAT/CLAYUCA</td>
</tr>
<tr>
<td>2. Review and analysis of information gathered through surveys currently being implemented (quantitative data on characterisation of market chain for cassava and sweet potato in Tanzania, Malawi and Zambia) (Pending activity)</td>
<td>Consultant teams (Phiri et al.) SARRNET Team CIAT/CLAYUCA CIP</td>
<td>Market chain for cassava flour and sweet potato characterized in Malawi Preliminary data on market chain for cassava products and sweet potato in Tanzania and Malawi available</td>
<td>Reliable data available for Malawi Preliminary data available for Tanzania Preliminary data available for Zambia</td>
<td>Waiting for final reports prepared by Phiri et al group.</td>
</tr>
</tbody>
</table>

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12 As discussed before, activities in Zambia will be limited to a minimum due to time constraints.
3.3. Theme III: Sustainable and appropriate processing technologies adopted by farmers and industrial processors.

Activity 1. Undertake feed formulation and industrial trials with private sector partners on the use of sweet potato and cassava in animal feeds with emphasis on poultry and cattle in Malawi and Tanzania.

- CIAT/CLAYUCA have been using the services of a Consultant (Dr. Julian Buitrago, Ph.D.), to achieve this objective.
- The consultant visited Tanzania in 2001 and Tanzania and Malawi in 2002.
- Two comprehensive reports submitted by the Consultant are presented in sections 7.0. and 8.0.

Activity 2. Establishment of pilot plant project using the integrated project approach in at least one country.

- As part of the work plan, SARRNET is expected to identify a potential site and potential partners in Malawi and Tanzania, to establish a pilot project based in the integrated research and development approach used by CIAT in Latin America. Given the time constraint and the need to move forward with this activity SARRNET coordination took the initiative of speeding up the establishment of the pilot project in both countries.
- During the visit of the consultancy team to Malawi in October–November 2001, based on previous contacts and information gathered by the SARRNET Team, a visit was paid to Christian Service Committee office in Mulanje, an NGO working in villages on both sides of the border with Mozambique. The findings of this initial meeting and the results of the work undertaken later under the Coordination of the SARRNET officers at Malawi are presented in the Annex 6.
- In recent months, the SARRNET team in Malawi has initiated activities in the community of Phalombe, selected as the pilot site. Improved cassava varieties were distributed. This work is now been complemented with activities based in the chipping and drying technology.
- In Tanzania, the potential site selected by the SARRNET team was the village Bungo (140 kmts south of Dar es Salaam). Section 5.3. presents the first data collected during this visit and the results of the follow up activities that have been coordinated by SARRNET officers at Tanzania.


- This activity is being conducted with direct participation of the book’s author, Dr. Julian Buitrago. CLAYUCA has hired a translator who undertakes the first translation and the draft text is edited and corrected by Dr. Buitrago.
- The content of the book is being updated and a new chapter on fish feeding will be included.
- Currently, nine chapters have been translated and are in process of edition.
- This activity is expected to be finished by September 2002.

Activity 4. Participation in process of translation of cassava post harvest handling and processing technology information system into English.

- The Spanish version of the information system, which is being developed by CIAT and CIRAD-amis, is in its final stages of completion.
- The translation of the content was initiated in September 2001.
- It is expected that the English version of the information system will be available in web format in September 2002.
### Theme III. Sustainable and appropriate processing technologies adopted by farmers and industrial processors.

<table>
<thead>
<tr>
<th>Activity and dates</th>
<th>Participants</th>
<th>Expected output</th>
<th>Indicator(s) for monitoring progress</th>
<th>Pending Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Undertake feed formulation and industrial trials with private sector partners on the use of sweet potato and cassava in animal feeds with emphasis on poultry and cattle in Malawi and Tanzania. (On-going activity)</td>
<td>SARRNET Team CIAT/CLAYUCA and local private &amp; public partners</td>
<td>Animal feed trial using cassava (initiated)</td>
<td>Biological data available</td>
<td>Technical, economical and biological data of the experiments conducted in Malawi needs to be collected (to be done by Vito). New experiences will be formulated, starting late November 2001 in TZ and Malawi. To be done by: Tanzania: Dev &amp; TAFIC Malawi: Vito &amp; partners See sections 7.0., 8.0 and 9.0. for updated information.</td>
</tr>
<tr>
<td>2. Establishment of at least one pilot plant project using the integrated product development approach in at least one country (On-going activity)</td>
<td>SARRNET Team CIAT/CLAYUCA and local private &amp; public partners</td>
<td>One pilot project in operation in Malawi One pilot project in operation in Tanzania</td>
<td>Pilot project operating Farmer’s group working under the pilot project concept. Volumes processed</td>
<td>Identification of local partner (institution and farmers) – Demonstration (sensitisation) of integrated project concept – Establishment of pilot processing plant – Operation of pilot processing plant – Complementary activities (production technologies) – Participatory Monitoring and evaluation To be done by: Tanzania: Sicco. Vianey, Malawi: Vito. France, Mahungu See section 4.6. for updated information on Malawi See section 5.3. for updated information on Tanzania</td>
</tr>
</tbody>
</table>
### Theme III. Sustainable and appropriate processing technologies adopted by farmers and industrial processors (continuation)

<table>
<thead>
<tr>
<th>Activity and dates</th>
<th>Participants</th>
<th>Expected output</th>
<th>Indicator(s) for monitoring progress</th>
<th>Pending Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Participation in process of translation of the book “The use of cassava in animal feeding” into English and formatting for web publication</td>
<td>B Ospina J. Buitrago</td>
<td>Book on “Use of cassava in animal feeding” translated into English and available for web publishing</td>
<td>Book available on the Web for stakeholders</td>
<td>Near 60% of the book is already translated (draft form) This activity will only be finished by September 2002</td>
</tr>
<tr>
<td>4. Participation in translation of cassava post-harvest handling and processing technology information system into English</td>
<td>R. Best B. Ospina</td>
<td>Information system translated into English and formatted for web publishing</td>
<td>Information system available in web page of SARRNET</td>
<td>Finish translation by September 2002</td>
</tr>
</tbody>
</table>

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14 This activity is financed by FOODNET
15 Some documents have already been made available at SARRNET offices
16 Some documents have already been made available at SARRNET offices
3.4. Theme IV: Stakeholders trained in new skills to support the market driven strategy at regional level.

Activity 1. Scientific mission of SARRNET team to Latin America

- This scientific exchange study tour was undertaken by from 24th February to 10th March. The SARRNET team was composed of: Dr. N. M. Mahungu (SARRNET Coordinator), Sicco Kolijn (SARRNET Post-harvest Scientist, Tanzania) and Vito Sandifolo (Integrated Projects Officer based at the SARRNET office in Malawi).
- A comprehensive trip report prepared by SARRNET team is included in section 6.0.


- Rupert Best and Bernardo Ospina participated in the SARRNET Steering Committee Meeting to be held in Pretoria, South Africa, from 28 April to 3 May 2002.
- Bernardo Ospina made a presentation on the advances of the collaborative agreement IITA/CIAI/SARRNET/CLAYUCA.
- Rupert Best and Bernardo Ospina participated in group and plenary discussion during the meeting.

Activity 3. Participation in the design, preparation and follow-up of a course on integrated root crop agroenterprises projects.

- The realization of this activity has not been defined yet. An alternative idea of replacing it with a workshop on the use of cassava and sweet potato in animal feed is currently being considered by SARRNET team. A first draft proposal for this activity is included in section 10.1.
- Another idea being currently discussed between SARRNET team and CIAT/CLAYUCA consultants is to organize a workshop for a selected group of multipliers. A first draft of this proposal is also included in section 10.2.
- During the Pretoria Steering Committee these activities were discussed. A final decision needs to be taken in the coming months.
### Theme IV. Stakeholders trained in new skills to support the market driven strategy.

<table>
<thead>
<tr>
<th>Activity and dates</th>
<th>Participants</th>
<th>Expected output</th>
<th>Indicator(s) for monitoring progress</th>
<th>Pending activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Scientific mission of SARRNET team to Latin America.</td>
<td>SARRNET Team</td>
<td>Updated knowledge of key SARRNET officers about cassava production and processing technologies with potential to be adapted to African countries</td>
<td>Trip report</td>
<td>See section 6.0. for more information on this activity</td>
</tr>
<tr>
<td>2. Participation in Steering Committee Meetings</td>
<td>R Best, B. Ospina</td>
<td>Rupert Best and Bernardo Ospina participated in the Steering Committee Meeting that took place in Pretoria, South Africa from April 28th to May 04th, 2002</td>
<td>Report of the Steering Committee</td>
<td></td>
</tr>
<tr>
<td>3. Participation in the design, preparation and follow-up of a course on integrated root crop agro enterprise projects. Date to be determined in 2002.</td>
<td>R Best, CF Ostertag, M Lundy, B. Ospina, J. Buitrego</td>
<td>Technical personnel of the national institutions involved in the integrated root crops agro enterprise projects trained in project design, execution and monitoring.</td>
<td>Report on training course, Project proposals and reports</td>
<td>National institutions in Tanzania, Malawi and Zambia selected for integrated project execution of SARRNET funded projects. CFC project personnel</td>
</tr>
</tbody>
</table>

**NOTE:** (The realization of this activity has not been defined yet. There is a possibility of replacing it by a workshop on the use of cassava and sweet potato in animal feeding)
4.0: ACTIVITIES IN MALAWI
### 4.1. Information gathered through contacts with Malawian industries

**Third round (October, November 2001), Fourth round (April, May 2002)**

<table>
<thead>
<tr>
<th>Organization &amp; Key Persons</th>
<th>Planned follow up activities</th>
<th>Results obtained</th>
<th>Planned activities not accomplished</th>
<th>General comments</th>
<th>Future activities and recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAB Processors Ltd</td>
<td>Maintain contacts</td>
<td>RAB has launched recently maize-cassava blend flours with excellent marketing results.</td>
<td>Animal feed trial</td>
<td>The product is now available in 5 and 10 kg packs.</td>
<td>Would like to establish contacts with cassava farmers as potential providers of mini-chips.</td>
</tr>
<tr>
<td>Physical Address:</td>
<td></td>
<td></td>
<td></td>
<td>10 Kg bag sold at 208 MK, initial price was 180 MK; attracting high demand.</td>
<td>If cassava farmers with good production potential are identified, try to establish marketing links with RAB.</td>
</tr>
<tr>
<td>Off Masauko Chimphembere Highway, Behind Toyota Malawi, Maselema, POB 5338 Limbe, Malawi</td>
<td></td>
<td></td>
<td></td>
<td>RAB has been buying dried roots (Makaka) at 9 MK from middleman.</td>
<td></td>
</tr>
<tr>
<td>Contact Person:</td>
<td></td>
<td></td>
<td></td>
<td>RAB estimates it needs 2000 MT Makaka for Nov-April period to keep product going.</td>
<td></td>
</tr>
<tr>
<td>Mr. Sai Kiran Josyabhatla (Operations Manager)</td>
<td></td>
<td></td>
<td></td>
<td>Maize sold at 319 MK.</td>
<td>To be done by SARRNET Team</td>
</tr>
<tr>
<td>Phone: (265)-645914 (direct)</td>
<td></td>
<td></td>
<td></td>
<td>Makaka needs to be scrapped before milling;</td>
<td></td>
</tr>
<tr>
<td>Cellular: 821516</td>
<td></td>
<td></td>
<td></td>
<td>RAB prefers to buy mini-chips as they also store longer (those produced with SARNNET chipper).</td>
<td></td>
</tr>
<tr>
<td>Email: <a href="mailto:rab@malawi.net">rab@malawi.net</a></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fax: 651804/651815</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visit: 5th November Bernardo, Sicco, Mahungu, Vito</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organization &amp; Key Persons</td>
<td>Planned follow up activities</td>
<td>Results obtained</td>
<td>Planned activities not accomplished</td>
<td>General comments</td>
<td>Future activities and recommendations</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-----------------------------</td>
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<td>-------------------------------------</td>
</tr>
<tr>
<td>Universal Industries</td>
<td>1. Provide a SARRNET chipper to Njuli farm</td>
<td>1. Done, working very well (see pictures next page)</td>
<td>Need to agree on payment of chipping machine</td>
<td>Company has bought 80 MT of Makaka from farmers. Has continued the use of cassava flour for biscuit production (estimated 30 MT/month). Coffee and cassava intercropping is used at Njuli farms. Droughts have affected coffee plants while the cassava plants were doing fine. (Picture 2). Near future development plan: Set up balanced feed plant using cassava and sweet potato as ingredients (Goal capacity: 2000 MT/month). A proposal has been submitted to DFID for a project in which SARRNET/CLA/YUCA are included as technical collaborators. Plans to launch cassava maize blend flour. Longer term future: Start production of starch and glucose for Malawi market.</td>
<td>Universal wants to establish an out-growers scheme for cassava production for food and feed. To install experimental plot at Njuli to validate production packages including fertilisation, varieties, and crop husbandry. Could be a good site for demonstrations and training activities with farmers. Try to link Universal to the farmer groups in Phalombe (pilot site), as the market for the cassava chips. To be done by: Vito/Mahungu</td>
</tr>
<tr>
<td>Factory Manager:</td>
<td></td>
<td></td>
<td>To be done by: Vito/Mahungu</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr. Jeff Salisbury</td>
<td>2. Give advice on cassava chipping and drying technology</td>
<td>1. Done, working very well (Pictures 3 and 4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farm Manager:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr. C.K. Dutt</td>
<td>2. Send commercial offer about CLAYUCA artificial drying plant</td>
<td>2. Two different, complete commercial proposals were delivered</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blantyre</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visited 14/05/2002</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Picture 1. Intercropping of coffee and cassava plants, Njuli Farm, Blantyre, Malawi.

Picture 2. Drought effect on coffee plants while cassava plants withstand the stress.

Picture 3. Drying of Cassava chips using plastic sheets and raised platforms

Picture 4. Drying of cassava chips using coffee dryer
<table>
<thead>
<tr>
<th>Organization &amp; Key Persons</th>
<th>Planned follow up activities</th>
<th>Results obtained</th>
<th>Planned activities not accomplished</th>
<th>General comments</th>
<th>Future activities and recommendations</th>
</tr>
</thead>
</table>
| ITL Plywood               | Send samples of high quality flour to ITL in June for tests in glue preparation. | 1. SARRNET initiated contacts between ITL and Kay Marketing (one of the suppliers of cassava flour in Blantyre) to supply the samples.  
2. 100 Kg sample of cassava flour was delivered and tested.  
3. Results were positive to the extent that ITL has now stopped buying wheat flour and is using 57 MT of cassava flour per annum. | None | The manager is now convinced after testing him self, that cassava is viable competitive ingredient in glue production. (Pictures 5, 6, 7 and 8)  
ITL is currently buying from middleman but prefers to buy directly from farmers’ groups.  
Wheat flour prices: 32 MK / kg  
Cassava flour prices: 15–20 MK / kg | If possible link ITL with cassava farmer groups at Phalombe (pilot site), that could supply the flour directly.  
To be done by: Vito/SARRNET Malawi |
5. Glue for paper making with cassava flour included.

7. Plywood production in Malawi with use of cassava flour, International Timber Limited, Blantyre

8. Bucket of glue containing cassava flour.
<table>
<thead>
<tr>
<th>Organization &amp; Key Persons</th>
<th>Planned follow up activities</th>
<th>Results obtained</th>
<th>Planned activities not accomplished</th>
<th>General comments</th>
<th>Future activities and recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trans Globe Produce Export Ltd.</td>
<td>1. Provide commercial samples of peeled and non-peeled cassava</td>
<td>1. Samples were delivered (Transglobe sent them to contacts in RSA).</td>
<td>None</td>
<td>Transglobe is still interested in export market of cassava chips to RSA despite this year’s scarcity and high prices of cassava.</td>
<td>Provide market information and cost-price of cassava chips in Zambia and Tanzania and identify local partners. To be done by: Sicco</td>
</tr>
<tr>
<td>Mr Andrew C. M. N Dalasini Business Development Manager</td>
<td>2. Provide samples of cassava leaves flour</td>
<td>2. A sample of 20 kg of cassava leaves was delivered</td>
<td></td>
<td>Would be interested in buying chips from Zambia or Tanzania producers to re-export to RSA.</td>
<td>If possible, try to link Transglobe with cassava farmer groups that could supply the flour directly. To be done by: Vito</td>
</tr>
<tr>
<td>Mr. Abubakar Swira Factory Manager</td>
<td>3. Send quotation of a chipper</td>
<td>3. Quotation was send</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Email: <a href="mailto:transglobe@malawi.net">transglobe@malawi.net</a></td>
<td>4. Maintain follow up on contacts with a south African company</td>
<td>4. Follow up was made and confirmed that a 100 MT Makaka was exported to contacts in RSA.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Address: Box 5035, Limbe, Malawi</td>
<td>Price of Makaka paid to farmers: 3–4 MKJ/kg, while export prices was 90 US$/MT fob Blantyre.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phone (265)-643488/643967/642761</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fax: (265)643620/642440</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visited: 7th November by Bernardo, Sicco, Mahungu &amp; Vito</td>
<td>5. Maintain follow up on the experiment on the use of cassava leaves for dairy feeding.</td>
<td>5. Experiment was conducted; data will be made available soon.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Organization &amp; key persons</td>
<td>Planned follow up activities</td>
<td>Results obtained</td>
<td>Planned activities not accomplished</td>
<td>General comments</td>
<td>Future activities and recommendations</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-----------------------------</td>
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<td>-------------------------------------</td>
<td>-----------------</td>
<td>--------------------------------------</td>
</tr>
<tr>
<td>Land O’ Lakes Inc.</td>
<td>Setting up field and feed</td>
<td></td>
<td>None</td>
<td>Land O’ Lakes has maintained its interest and commitment to participate in SARRNET activities in Malawi</td>
<td>Give logistical support and follow up to Land O’ Lakes and collaborators in the implementation of the trials proposed</td>
</tr>
<tr>
<td>Malawi Dairy Business</td>
<td>experiments based on the use of cassava leaves in dairy cattle feeding through silage technology</td>
<td></td>
<td></td>
<td>Collaborators for conducting the animal feeding trials have been identified: dairy farmers, Land O’ Lakes, CREMPA (Central region Milk producers Association), and the Livestock section of the Department of Agricultural Research and Technical Services in the Ministry of Agriculture.</td>
<td>Julian Buitrago will be accessible through e-mail for any consultation regarding the trials</td>
</tr>
<tr>
<td>Development Programme</td>
<td></td>
<td></td>
<td></td>
<td>The current uncertainty of local supply of maize and the shortage of oil seeds such as sunflower, cotton, soybeans and groundnuts have created a sound opportunity for cassava to enter the dairy sector market as sustainable alternative raw material for animal feeding</td>
<td></td>
</tr>
<tr>
<td>Mr. Austin Ngwira</td>
<td></td>
<td></td>
<td></td>
<td>During the visit of CLAYUCA consultant to Malawi (May 2002), some concrete activities were planned with involvement of Land O’ Lakes and other partners. The fact that SARRNET now has its own plantings of cassava and sweet potato will facilitate the implementation of these trials</td>
<td></td>
</tr>
<tr>
<td>Country Coordinator</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location: Akulunje Arcade, Murria Road, Private Bag A148 Lilongwe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phone: 753772 (O) 766285 (Home) Fax: 753773 Mobil: 833366</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Email: <a href="mailto:Lolmalawi@sdnp.org.mw">Lolmalawi@sdnp.org.mw</a> <a href="mailto:ngwira@hotmail.com">ngwira@hotmail.com</a></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visited: 12/3/2001 13-15/05/2002</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. In November 2001, a complete set of experiments prepared by Julian Buitrago was delivered to Mr. Ngwira (See next section)

2. Arrangements were discussed between Land O’ Lakes and SARRNET Malawi Team to provide cassava leaves and cassava roots flour needed for the experiment

3. Some field demonstrations were planned with farmers’ groups (Pictures 9 and 10)

4. Information on animal feeding technologies using cassava roots and leaves was given to Mr. Ngwira in the form of videos and written materials

5. In May 2002, Julian Buitrago, supported by SARRNET team in Malawi, spent three days giving direct advice to Land O’ Lakes (Pictures 11, 12 and 13)
Picture 9. Field day at Chitedze-Chipping technology

Picture 10. Field day at Chitedze-Pit type silage

Picture 11. Field day at Chitedze. Cage type silages.

Picture 12. Mixing components in silage making.

Picture 13. Final silage product. (Cassava roots, cassava leaves, sweet potato and molasses.)
<table>
<thead>
<tr>
<th>Organization &amp; key persons</th>
<th>Planned follow up activities</th>
<th>Results obtained</th>
<th>Planned activities not accomplished</th>
<th>General comments</th>
<th>Future activities and recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chitipi Farms, Lilongwe</td>
<td>Give technical advice for the setting up a large cassava plantation (55 ha), with the objective of linking its production to one or more of the emerging markets for the crop (dry cassava feed, starch or fresh cassava) (Picture 14)</td>
<td>SARRNET-Malawi gave the planting material and technical assistance for the installation of the area (Picture 19)</td>
<td>None</td>
<td>Crop development has been very good. A reasonable good yield is expected (25–30 ton/ha) (Pictures 15 and 16)</td>
<td>Assist and get reliable data on yields to develop sheet of production costs. See first draft next page (Costa, Vito)</td>
</tr>
<tr>
<td></td>
<td>Give technical assistance and backstopping to the plantation during the growing period</td>
<td>SARRNET-Malawi has been giving technical assistance since the planting (November, 2001)</td>
<td></td>
<td>Contacts have already been made with owners by several potential buyers of the crop (fresh and dried chips)</td>
<td>Assist on commercialisation phase</td>
</tr>
<tr>
<td></td>
<td>Give information to collaborators at Chitipi Farms about different market options, processing technologies, prices, etc.</td>
<td>Consultancy team gave all the information requested to the collaborators A preliminary production cost structure was prepared for further monitoring and follow up.</td>
<td></td>
<td>Good opportunity for reliable data on commercial scale cassava production costs in Malawi</td>
<td>Find as fast as possible information on washing and peeling machine (Sicco, Ospina)</td>
</tr>
<tr>
<td>Mr. Jan Davidse</td>
<td>Visited: 12/3/2001 10–13/05/2002</td>
<td></td>
<td></td>
<td>For SARRNET, this activity has been an excellent demonstration effect that has drawn the attention of high-ranking officers at the Ministry of Agriculture of Malawi, NGOs and other private sector enterprises.</td>
<td>Implement trial with tray drying technology which seems very easy to adapt to this farm considering the existence of drying structure for tobacco (Picture 17). (Vito, Sicco)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Termite’s attack is a current serious problem. Farmer needs options besides chemical treatment which is very dangerous (Picture 18)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>A new survey on cassava has been initiated in Malawi by Bunda College (IDEAA)</td>
<td></td>
</tr>
</tbody>
</table>
Picture 14. Cassava planting at 90 x 75 cm (November 2001)

Picture 15. Cassava plants 6 months after planting (May 2002)

Picture 16. Root formation at 6 months (May 2002)

Picture 17. Termites attack

Picture 18. Tobacco dying structures

Picture 19. Commercial cassava plantation in Malawi (55 has)
<table>
<thead>
<tr>
<th>Organization &amp; key persons</th>
<th>Planned follow up activities</th>
<th>Results obtained</th>
<th>Planned activities not accomplished</th>
<th>General comments</th>
<th>Future activities and recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Region Milk Producers Association (CREMPA)</td>
<td>Cassava and sweet potato planting materials were distributed to dairy farmers belonging to the Central Region Milk Producers Association.</td>
<td>None</td>
<td>- Cassava is a new crop for farmers. Sweet potato is a crop established and used by them.</td>
<td>Need to develop and introduce, as quick as possible, a shipping and chopping machine that can be used for both, the roots and the leaves. (Sicco &amp; Vito &amp; CLAYUCA)</td>
<td>Need to introduce and demonstrate silage technology (cheaper, easier)</td>
</tr>
<tr>
<td>Visited: 11/05/2002</td>
<td>Three bulking groups of Lumbadzi, Chimbiya and Likuni received and planted materials of two cassava varieties, Mbundumali and Silira and three sweet potato varieties Kenya, Semusa and Mugamba. Collaborators for the preliminary animal feeding trials have been identified: dairy farmers belonging to CREMPA, Land O' Lakes and the Livestock section of the Department of Agricultural Research and Technical Services in the Ministry of Agriculture. These trials will be conducted in the period August–December, 2002.</td>
<td></td>
<td>- The use of both crops will be for double purpose: food and feed. Farmers are already using cassava leaves for food. (Picture 22)</td>
<td>Organise field days for farmers at Chitedze station to demonstrate the intensive cassava, and sweet potato production system (roots and leaves)</td>
<td>Set up on-farm fertilisation trials (next season)</td>
</tr>
<tr>
<td>Visited by; VS, BO, SK and JB</td>
<td></td>
<td></td>
<td>- Very poor soil fertility and farmers do not use any chemical fertilizer. Organic manure is used in limited amounts. Farmers use crop residues to feed animals (Picture 21)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Milk production is a very important cash generating activity. Current farm gate price is 17 MK per litre (Picture 23)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- CREMPA could be a very important partner for SARRNET in Malawi due to a) good capacity for linking other collaborators and b) offering a demonstration site near Lilongwe.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Picture 20. Sweet potato and cassava intercropping.

Picture 21. Low soil fertility; 3 months old cassava.

Picture 22. Cassava seen as a new crop by farmers for food and feed both food and feed.

Picture 23. Zero grazing dairy system.
<table>
<thead>
<tr>
<th>Organization &amp; key persons</th>
<th>Planned follow up activities</th>
<th>Results obtained</th>
<th>Planned activities not accomplished</th>
<th>General comments</th>
<th>Future activities and recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kandiyani Experimental Fields</td>
<td>Cassava leaf production trials have been planted at Kandiyani Experimental fields near Chitedze. Trials were planted in October 2001, using 3 varieties and sprinkler irrigation. Four different plant spacing were used: 1x1 m, 90x50, 50x50, 30x30 cm (Picture 24). Urea fertiliser was applied at 200 kg/ha one month after planting. First leaf harvest was done in February 2002. Two types of harvesting are used: ratooning and topping (Picture 25). Cassava and sweet potato leaf and root silage technology has been initiated using pit system. Sweet Potato leaves production trial has been initiated (Picture 27).</td>
<td>Results obtained with the intensive leaf production trials are impressive. Very good yields have been obtained. The results of the trial for intensive production of sweet potato leaves are impressive, especially with the variety. There is a great potential for this technology to be easily adopted by farmers groups associated to Land O’ Lakes.</td>
<td>The size of the experimental plot is very large; demanding lots of staff time and hired labour to collect data and maintain the fields. i.e. the ratooning versus de-topping comparison (see picture next page). The choice made for silage technology (pit) is complicated; demands a lot of labour and has high cost (Picture 26). There are simpler options such as the ones used in Tanzania (Plastic bags). So far, chopping of leaves is done by hand. This may limit technology adoption by farmers. There is a need to develop a simple machine for this purpose</td>
<td>There is a urgent need to introduce and promote small scale chipping-chopping equipment for cassava and sweet potato (Action: Vito and Sicco). Need to improve the silage methods by adding fresh or dried cassava chips and/or molasses. Initiate trials using plastic bags for silage of around 50 kgs of product. This bags can be used at the station for monitoring and demonstration purposes elsewhere.</td>
<td></td>
</tr>
</tbody>
</table>
Picture 24. Plant spacing treatments

Picture 25. De-topping versus ratooning harvest system

Picture 26. Pit silage system

Picture 27. Sweet Potato leaves production trials
4.2. Animal Feeding Experiment Proposed for Malawi

Demonstration trial with ensiled cassava roots and leaves for dairy feeding (proposed in November, 2001)

Planning: SARRNET–CLAYUCA
Land O’ Lakes–Malawi
Dairy Farmers–Malawi

Location: Dairy farmers, Malawi

4.2.1. Objectives

To evaluate a feeding program for dairy cows totally based on cassava roots and leaves.

To calculate the cropping area needs for both intensive cassava forage and intensive root production for a dairy operation based on cassava as the principal feed resource.

4.2.2. Materials and Methods

Cropping area and ensiling procedure

The final daily diet will be based on a leaves to roots ratio equivalent of 2 : 1 (two parts of cassava leaves : 1 part of cassava roots).

Taking into account the potential yields of separate cropping experiences with intensive leaf production (10–20 tons every three months) and intensive root production (20–25 tons every 12 months), the approximately cropping area for each material should be calculated.

Since the daily diet will be provided in an ad libitum basis of a silage mixture, the ensiled formulation should be prepared following the same proportion: 2 parts of fresh leaves to 1 part of fresh roots.

After the cassava roots and leaves crops have been collected, the material has to be chipped, mixed (2 : 1 ratio), packed and ensiled in plastic bags. The bags should be closed trying to eliminate as much air as possible from the ensiled material. A small hole will be opened at the bottom of each bag to facilitate drainage of water during the ensiling process.

Ensiled bags will be stored for a minimum of two weeks in order to complete the silage process. After 15–20 days, the bags will be opened according to the daily feeding needs. The remaining bags can be opened every day until new silage is prepared. Ensiled bags may remain for at least one year, if the ensiled mixture has been properly prepared and stored.
Experimental animals

Milking cows will be included in a feeding demonstration where most of the daily feed will be provided by the ensiled cassava leaf/root mixture. One control group under the standard feeding conditions should be included, if possible.

Sanitary and management conditions will be the same in all groups. *Ad libitum* feed will be provided for all treatments. Milking cows may remain on grazing conditions or semi-confined conditions.

Experimental diets

The cassava silage will be prepared at the farm facilities under the supervision of SARRNET and Land O’ Lakes technicians. The control group will be fed a normal commercial diet or the normal grazing program at the farm level.

The ensiled cassava leaf/root mixture will be provided every day to the experimental animals. Feed consumption will be based on farm variables, including the type of animals and the local productivity.

For high yielding cows an approximate consumption based on 12 to 13 percent of the body weight should provide the needed nutrients for semi-confined animals (i.e. a 400 kg cow may consume between 48 to 52 kg of ensiled material). If animals receive some grazing or green forage, adjustments should be introduced according to the farm management program. All animals should receive a mineral–salt mixture and clean water as a complement to silage.

Experimental data to be taken

Individual weight records of cows at starting day and last day of the experiment.
Daily milk production per cow.
Daily feed consumption per cow.
Sanitary conditions of cows.
Costs: Cost (per kilogram) of commercial and experimental diets.
Total production costs

4.2.3. Daily feeding program in total or semi-confined conditions

The 2 to 1 leaves to roots ratio has been proposed as a balanced energy: protein mixture, which will provide most nutrients for lactating cows under confined or semi-confined conditions. If other feed resources (forages, molasses, pasture, urea, etc.) are included, the ratio and/or daily consumption should be changed.

The approximate amount of the ensiled mixture depend on several variables, but a total consumption based on 12 to 13 % of total body weight is recommended. For example, a 400 lactating cow will need around 48–50 kg of the 2:1 ensiled cassava mixture. This mixture will provide around 1,400 grams of protein and 8.2 kg of TDN per day. *Ad libitum* mineralised salt should be provided or an approximate daily allowance of 120–150 grams per head.
4.3. Cassava Production Costs in Malawi—a First Approximation

In October 2001, SARRNET started to collaborate with a group of three private farmers in Malawi that set up the first commercial scale cassava plantation in the country. The area planted was 55 has. SARRNET contributed with some planting material and has been giving technical assistance during the growing period. During the recent visit of the CLAYUCA consultancy team, an effort was made to estimate real production costs that can be used later to orientate farmers in making decisions related to commercialisation of the crop. The costs used in this estimate were obtained directly with the farmer in charge of managing the plantation. (See Table 2)

Table 2. Commercial cassava planting in Malawi—Costs of production.
A first estimate (May 2002), (Malawian Kwachas)

<table>
<thead>
<tr>
<th>Item / activity</th>
<th>Productivity level (MT/ha)</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land renting</td>
<td></td>
<td>1100</td>
<td>1100</td>
<td>1100</td>
<td>1100</td>
</tr>
<tr>
<td>Land preparation (including ridging)</td>
<td></td>
<td>1600</td>
<td>1600</td>
<td>1600</td>
<td>1600</td>
</tr>
<tr>
<td>Planting (20 persons/day @50 MK)</td>
<td></td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>Seeds</td>
<td></td>
<td>7000</td>
<td>7000</td>
<td>7000</td>
<td>7000</td>
</tr>
<tr>
<td>Weeding (3 times)</td>
<td></td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>Fertiliser (6 bags @1400 MK)</td>
<td></td>
<td>8400</td>
<td>8400</td>
<td>8400</td>
<td>8400</td>
</tr>
<tr>
<td>Harvesting (500 kg/person @50MK)</td>
<td></td>
<td>1500</td>
<td>2000</td>
<td>2500</td>
<td>3000</td>
</tr>
<tr>
<td>Security</td>
<td></td>
<td>3600</td>
<td>3600</td>
<td>3600</td>
<td>3600</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>25200</td>
<td>25700</td>
<td>26200</td>
<td>26700</td>
</tr>
<tr>
<td>Production costs (MK/kg)</td>
<td></td>
<td>1.68</td>
<td>1.29</td>
<td>1.03</td>
<td>0.86</td>
</tr>
<tr>
<td>Production costs (USD/ha)</td>
<td></td>
<td>331.6</td>
<td>338.2</td>
<td>344.7</td>
<td>351.3</td>
</tr>
<tr>
<td>Production cost in (USD/MT)</td>
<td></td>
<td>22.1</td>
<td>16.9</td>
<td>13.8</td>
<td>11.7</td>
</tr>
</tbody>
</table>

To estimate net income, two main market options for the crop must be considered: the fresh market and the dry chips for animal feeding market. Both markets are different, require different labour and offer different prices. The following analysis considers both options.

4.3.1. Fresh cassava market

This market offers a great advantage because the product can be sold in the capital (Lilongwe) reducing considerably the transportation costs since the plantation is located very near the city. To estimate the potential net income with this market, four different prices for cassava roots in the fresh market were considered (Table 3).
<table>
<thead>
<tr>
<th>Item / activity</th>
<th>Productivity level (MT/ha)</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production costs (MK/kg)</td>
<td></td>
<td>1.68</td>
<td>1.29</td>
<td>1.03</td>
<td>0.86</td>
</tr>
<tr>
<td>Production costs (USD/ton)</td>
<td></td>
<td>22.1</td>
<td>16.9</td>
<td>13.8</td>
<td>11.7</td>
</tr>
<tr>
<td>Fresh market price (MK/kg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td></td>
<td>-0.18</td>
<td>0.21</td>
<td>0.47</td>
<td>0.66</td>
</tr>
<tr>
<td>2.0</td>
<td></td>
<td>0.32</td>
<td>0.71</td>
<td>0.97</td>
<td>1.14</td>
</tr>
<tr>
<td>3.0</td>
<td></td>
<td>1.32</td>
<td>1.71</td>
<td>1.97</td>
<td>2.14</td>
</tr>
<tr>
<td>4.0</td>
<td></td>
<td>2.32</td>
<td>2.71</td>
<td>2.97</td>
<td>3.14</td>
</tr>
<tr>
<td>Net profit (MK/kg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td></td>
<td>-180</td>
<td>210</td>
<td>470</td>
<td>660</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>320</td>
<td>715</td>
<td>970</td>
<td>1140</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>1320</td>
<td>1710</td>
<td>1970</td>
<td>2140</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>2320</td>
<td>2710</td>
<td>2970</td>
<td>3140</td>
</tr>
<tr>
<td>Net profit (MK/ton)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td></td>
<td>-2700</td>
<td>4200</td>
<td>11750</td>
<td>19800</td>
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<tr>
<td>2</td>
<td></td>
<td>4800</td>
<td>14200</td>
<td>24250</td>
<td>34200</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>19800</td>
<td>34200</td>
<td>49250</td>
<td>64200</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>34800</td>
<td>54200</td>
<td>74250</td>
<td>94200</td>
</tr>
<tr>
<td>Net profit (MK/ha)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td></td>
<td>15</td>
<td>20</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>55.3</td>
<td>154.6</td>
<td>260</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>186.9</td>
<td>319.0</td>
<td>450</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>451</td>
<td>648</td>
<td>845</td>
<td></td>
</tr>
<tr>
<td>Net profit (USD/ha)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td></td>
<td>-35</td>
<td>55.3</td>
<td>154.6</td>
<td>260</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>63.1</td>
<td>186.9</td>
<td>319.0</td>
<td>450</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>260.5</td>
<td>451</td>
<td>648</td>
<td>845</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>457.9</td>
<td>713.1</td>
<td>977.5</td>
<td>1240</td>
</tr>
</tbody>
</table>

Note: 1 USD = 76 Malawian Kwachas (May 2002)

Figure 1. Net profit for cassava production in Malawi. Fresh market (May 2002)
According to the data obtained (Tables 2, 3 and Figure 1) it can be concluded that the potential for producing cassava in Malawi, on a competitive basis, is very high. Production costs in the range of 15 to 22 dollars per ton can be very promising for entering the fresh market. The data obtained has been based on assumptions for some items and needs to be validated at harvest time. To attain yields at the level of 30 ton/ha may not be an easy task but even at the level of 20 ton/ha, the net profit could still be very attractive.

4.3.2. **Dry cassava chips for animal feed or cassava flour market**

This market may imply some transportation cost since the potential clients, biscuit factories and the animal feed companies are located in other cities. Also, the processing of the roots into chips (peeling, shipping, drying), will involve additional costs that have to be taken into account. A positive factor of this market outlet is that it will generate some additional employment in the post harvest handling of the crop, especially in the peeling of the roots.

To estimate the potential net income with this market, it is assumed that the whole production is transformed into dry chips. The net income is calculated using four different market prices for the dry chips (Table 3 and Figure 2).

Data obtained indicates that with yields of 15 ton/ha, the price of cassava chips has to be at least 10 kwachas per kg to make some profit. If the productivity is at least 20 ton/ha, the chips can be sold at 8 kwachas per kg with some profit. During the last visit of CLAYUCA’s consultancy team, the biscuit factory was willing to purchase the chips at 12 kwachas per kg, but delivered at Blantyre. Transportations costs could prove to be the most important issue to enter this market. If productivity is around 20 ton per ha and the transportation costs is not more than 1 kwacha per kg, there is a good margin for profits. SARRNET team in Malawi must maintain a careful monitoring of the variations in these data to be able to give sound advice to the farmers that own the commercial plantation.

The comparison of the two market options (Figure 3), indicates that for both markets, there is a good potential for reasonable net income, especially if the productivity levels are at least 20 ton per ha and if the prices are high for both the fresh market and the dry chips. The other risk factor that could affect the final results is the persistent presence and attack of termites in the cassava plantation. Any advice from the IPM teams at IITA and CIAT.
Table 4. Net income for cassava production in Malawi. Dry chips market. (May 2002)

<table>
<thead>
<tr>
<th>Item / activity</th>
<th>Productivity level (MT/ha)</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production costs (MK/kg)</td>
<td></td>
<td>1.68</td>
<td>1.29</td>
<td>1.03</td>
<td>0.86</td>
</tr>
<tr>
<td>Total production (kg/ha)</td>
<td></td>
<td>15000</td>
<td>20000</td>
<td>25000</td>
<td>30000</td>
</tr>
<tr>
<td>Total cost of raw material (MK/ha)</td>
<td></td>
<td>25200</td>
<td>25800</td>
<td>25750</td>
<td>25800</td>
</tr>
<tr>
<td>Processing efficiency (kg fresh roots/kg dry chips)</td>
<td></td>
<td>3.3</td>
<td>3.3</td>
<td>3.3</td>
<td>3.3</td>
</tr>
<tr>
<td>Total amount of dried chips (kg/ha)</td>
<td></td>
<td>4545</td>
<td>6061</td>
<td>7576</td>
<td>9091</td>
</tr>
<tr>
<td>Processing costs per kg of dry chips (MK)</td>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Total processing costs (MK/ha)</td>
<td></td>
<td>13635</td>
<td>18183</td>
<td>22728</td>
<td>27273</td>
</tr>
<tr>
<td>Total costs of raw material + processing (MK/ha)</td>
<td></td>
<td>38835</td>
<td>43983</td>
<td>48478</td>
<td>53073</td>
</tr>
</tbody>
</table>

Net income (MK/ha)

<table>
<thead>
<tr>
<th>Price of dry cassava chips (MK/kg)</th>
<th>Productivity (ton/ha)</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>-2475</td>
<td>4505</td>
<td>12130</td>
<td>19655</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>6615</td>
<td>16627</td>
<td>27282</td>
<td>37837</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>15705</td>
<td>28749</td>
<td>42434</td>
<td>56019</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>24795</td>
<td>40871</td>
<td>57586</td>
<td>74201</td>
<td></td>
</tr>
</tbody>
</table>

Net income (USD/ha)

<table>
<thead>
<tr>
<th>Price of dry cassava chips (MK/kg)</th>
<th>Productivity (ton/ha)</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>-32.6</td>
<td>59.3</td>
<td>159.6</td>
<td>258.6</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>87.0</td>
<td>218.8</td>
<td>359.0</td>
<td>497.9</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>206.7</td>
<td>378.3</td>
<td>558.3</td>
<td>737.1</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>326.3</td>
<td>537.8</td>
<td>757.7</td>
<td>976.3</td>
<td></td>
</tr>
</tbody>
</table>

*1 = Costs of processing (peeling, chipping and drying) is assumed. Needs to be confirmed under real conditions.*

Figure 2. Net income from dry cassava chip market in Malawi (May 2002)
Figure 3. Net income from fresh and dry cassava chip markets in Malawi (May 2002)
4.4. Cassava production in Malawi–field trials

SARRNET initiated in October 2001 some field trials aimed at evaluating the technical and economic feasibility of intensive production systems for cassava and sweet potato leaves and roots in Malawi. These trials have been conducted at the experimental site Kindajani, nearby the Chitedze research station in Lilongwe. These trials have several positive aspects for SARRNET: a) the convenience of having a demonstration site near the central office of the network that can use for field days and training purposes with technical personnel, farmers and other interested groups, b) the possibility of getting more control over a source of good quality planting material for both, cassava and sweet potato and c) the importance of having a testing ground for adaptation and validation of technologies that can be later transferred to farmers. The trials have been growing during the last semester and some data is already available about the first harvest. The data obtained is presented and discussed in the next section.

4.4.1. Cassava leaves production trial–Ratooning system

Treatments: three varieties (Silira, Mbundumali, Maunjiri)
Four planting distances: (1x1); (0.5 x 0.5); (0.9 x 0.50) and (0.30 x 0.30) meters
Three repetitions, planting date: October 2001.
First harvest: February 12, 2002
Area harvested: 15,6 sq.mt
Harvest system: ratooning

Table 5. Cassava leaves trials in Malawi–2001–2002

<table>
<thead>
<tr>
<th>Treatment (Variety x planting distance)</th>
<th>Fresh weight (kg)</th>
<th>Fresh weight (ton/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silira (1 x 1)</td>
<td>27.9</td>
<td>17.9</td>
</tr>
<tr>
<td>Mbundumali (1x1)</td>
<td>27.4</td>
<td>17.6</td>
</tr>
<tr>
<td>Maunjiri (1x1)</td>
<td>25.6</td>
<td>16.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silira (0.5x 0.5)</td>
<td>26.3</td>
<td>16.9</td>
</tr>
<tr>
<td>Mbundumali (0.5x 0.5)</td>
<td>28.0</td>
<td>18.0</td>
</tr>
<tr>
<td>Maunjiri (0.5 x 0.5)</td>
<td>27.2</td>
<td>17.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silira (0.9x 0.5)</td>
<td>14.2</td>
<td>9.1</td>
</tr>
<tr>
<td>Mbundumali (0.9x 0.5)</td>
<td>24.3</td>
<td>15.6</td>
</tr>
<tr>
<td>Maunjiri (0.9x 0.5)</td>
<td>10.0</td>
<td>6.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silira (0.3 x 0.3)</td>
<td>43.0</td>
<td>27.5</td>
</tr>
<tr>
<td>Mbundumali (0.3 x 0.3)</td>
<td>35.9</td>
<td>23.0</td>
</tr>
<tr>
<td>Maunjiri (0.3 x 0.3)</td>
<td>21.0</td>
<td>13.5</td>
</tr>
</tbody>
</table>

*Fresh weight is the average of three repetitions
Figure 4. Cassava leaves production trial in Malawi Ratooning system, first harvest

Figure 5. Cassava leaves production trial in Malawi Ratooning system, first harvest

<table>
<thead>
<tr>
<th>Treatment (Variety x planting distance)</th>
<th>Fresh weight (kg)</th>
<th>Fresh weight (ton/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silira (1 x 1)</td>
<td>9.3</td>
<td>6.0</td>
</tr>
<tr>
<td>Mbundumali (1x1)</td>
<td>10.7</td>
<td>6.8</td>
</tr>
<tr>
<td>Maunjiri (1x1)</td>
<td>8.2</td>
<td>5.3</td>
</tr>
<tr>
<td>Silira (0.5x 0.5)</td>
<td>9.7</td>
<td>6.2</td>
</tr>
<tr>
<td>Mbundumali (0.5x 0.5)</td>
<td>8.3</td>
<td>5.3</td>
</tr>
<tr>
<td>Maunjiri (0.5 x 0.5)</td>
<td>12.1</td>
<td>7.7</td>
</tr>
<tr>
<td>Silira (0.9x 0.5)</td>
<td>6.7</td>
<td>4.3</td>
</tr>
<tr>
<td>Mbundumali (0.9x 0.5)</td>
<td>8.5</td>
<td>5.5</td>
</tr>
<tr>
<td>Maunjiri (0.9x 0.5)</td>
<td>9.0</td>
<td>5.8</td>
</tr>
<tr>
<td>Silira (0.3 x 0.3)</td>
<td>11.5</td>
<td>4.8</td>
</tr>
<tr>
<td>4.8</td>
<td>10.7</td>
<td>6.8</td>
</tr>
<tr>
<td>Maunjiri (0.3 x 0.3)</td>
<td>12.0</td>
<td>7.7</td>
</tr>
</tbody>
</table>

- Fresh weight is the average of three repetitions
- Harvest date: April 22, 2002; Area harvested: 15.6 sq.m; Harvest system: ratooning

Figure 6. Cassava leaves production trial in Malawi Ratooning system, second harvest

Planting distances (meters)
Varieties

Results obtained in the second harvest are considerably lower. The factor that could probably explain the drop in yield is the fact that plants were harvested with only two months of growth after the first harvest when the recommendation is to leave at least three months between each harvest.
4.4.2. Cassava leaves production trial—Detopping system

The experimental work with intensive cassava leaves system in Malawi is also including a comparison between the ratooning and the detopping systems. The main difference is that the height of the plant at which the harvest is done. With the ratooning system, the cutting is done at the same height, about 20 cm from the floor whereas with the detopping, the height at which the cut is done is usually higher.

The treatments, repetitions, planting distances and management of the crop were the same. Treatments: three varieties (Silira, Mbundumali, Maunjiri)
Four planting distances: (1x 1); (0.5 x 0.5); (0.9 x 0.50) and (0.30 x 0.30) meters
Three repetitions, planting date: October 2001.
First harvest: February 12, 2002
Area harvested: 15.6 sq. mt.; Harvest system: detopping

Table 7. Cassava leaves trials in Malawi. 2001–2002. Dettoping harvest system

<table>
<thead>
<tr>
<th>Treatment (Variety x planting distance)</th>
<th>Fresh weight (kg)*</th>
<th>Fresh weight (ton/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silira (1 x 1)</td>
<td>23.4</td>
<td>15.0</td>
</tr>
<tr>
<td>Mbundumali (1x1)</td>
<td>20.5</td>
<td>13.1</td>
</tr>
<tr>
<td>Maunjiri (1x1)</td>
<td>13.6</td>
<td>13.1</td>
</tr>
<tr>
<td>Silira (0.5x 0.5)</td>
<td>23.6</td>
<td>15.2</td>
</tr>
<tr>
<td>Mbundumali (0.5x 0.5)</td>
<td>15.5</td>
<td>9.9</td>
</tr>
<tr>
<td>Maunjiri (0.5 x 0.5)</td>
<td>16.7</td>
<td>10.7</td>
</tr>
<tr>
<td>Silira (0.9x 0.5)</td>
<td>12.1</td>
<td>7.8</td>
</tr>
<tr>
<td>Mbundumali (0.9x 0.5)</td>
<td>14.2</td>
<td>9.1</td>
</tr>
<tr>
<td>Maunjiri (0.9x 0.5)</td>
<td>9.3</td>
<td>6.0</td>
</tr>
<tr>
<td>Silira (0.3 x 0.3)</td>
<td>44.7</td>
<td>28.7</td>
</tr>
<tr>
<td>Mbundumali (0.3 x 0.3)</td>
<td>24.3</td>
<td>15.6</td>
</tr>
<tr>
<td>Maunjiri (0.3 x 0.3)</td>
<td>14.7</td>
<td>9.4</td>
</tr>
</tbody>
</table>

*Fresh weight is the average of three repetitions
Figure 9. Cassava leaves production trial in Malawi Detopping system, first harvest

<table>
<thead>
<tr>
<th>Planting distances (meters)</th>
<th>Silira</th>
<th>Mbundumali</th>
<th>Maunjiri</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 x 1</td>
<td>15</td>
<td>13.1</td>
<td></td>
</tr>
<tr>
<td>0.5 x 0.5</td>
<td>15.1</td>
<td>10.7</td>
<td></td>
</tr>
<tr>
<td>0.9 x 0.5</td>
<td>7.8</td>
<td>9.1</td>
<td>6</td>
</tr>
<tr>
<td>0.3 x 0.3</td>
<td>28.7</td>
<td>15.6</td>
<td>9.4</td>
</tr>
</tbody>
</table>

Figure 10. Cassava leaves production trial in Malawi Detopping system, first harvest

<table>
<thead>
<tr>
<th>Varieties</th>
<th>1 x 1</th>
<th>0.5 x 0.5</th>
<th>0.9 x 0.5</th>
<th>0.3 x 0.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silira</td>
<td>15</td>
<td>7.8</td>
<td>13.1</td>
<td>10.7</td>
</tr>
<tr>
<td>Mbundumali</td>
<td>13.1</td>
<td>9.1</td>
<td>15.6</td>
<td>6</td>
</tr>
<tr>
<td>Maunjiri</td>
<td>13.1</td>
<td></td>
<td>13.1</td>
<td>9.4</td>
</tr>
</tbody>
</table>
Table 8 Cassava leaves trials in Malawi. 2001–2002
Detopping system. Second harvest

<table>
<thead>
<tr>
<th>Treatment (Variety x planting distance)</th>
<th>Fresh weight (kg) *</th>
<th>Fresh weight (ton/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silira (1 x 1)</td>
<td>9.1</td>
<td>5.9</td>
</tr>
<tr>
<td>Mbundumali (1x1)</td>
<td>11.4</td>
<td>7.3</td>
</tr>
<tr>
<td>Maunjiri (1x1)</td>
<td>4.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Silira (0.5x 0.5)</td>
<td>5.2</td>
<td>3.3</td>
</tr>
<tr>
<td>Mbundumali (0.5x 0.5)</td>
<td>7.5</td>
<td>4.8</td>
</tr>
<tr>
<td>Maunjiri (0.5 x 0.5)</td>
<td>11.4</td>
<td>7.3</td>
</tr>
<tr>
<td>Silira (0.9x 0.5)</td>
<td>4.5</td>
<td>2.9</td>
</tr>
<tr>
<td>Mbundumali (0.9x 0.5)</td>
<td>8.7</td>
<td>5.6</td>
</tr>
<tr>
<td>Maunjiri (0.9x 0.5)</td>
<td>9.5</td>
<td>6.1</td>
</tr>
<tr>
<td>Silira (0.3 x 0.3)</td>
<td>7.8</td>
<td>5.0</td>
</tr>
<tr>
<td>4.8</td>
<td>12.1</td>
<td>7.8</td>
</tr>
<tr>
<td>Maunjiri (0.3 x 0.3)</td>
<td>9.7</td>
<td>6.2</td>
</tr>
</tbody>
</table>

* Fresh weight is the average of three repetitions; Harvest date: April 22, 2002
Area harvested: 15.6 sq.m

Figure 11. Cassava leaves production trial in Malawi Detopping system, second harvest
Results obtained in the second harvest with the detopping system were also lower than with the first harvest. In some cases, there seems to be an effect of the cutting system since yields with the detopping method were lower during the second harvest in comparison with the ratooning system. The variety Mbundumali, although it was not the more productive during the first harvest, presented the best yields during the second harvest.
4.5. Sweet potato leaves production trial

Another interesting work initiated this year in Malawi is related to the production of sweet potato leaves under intensive system as a source of protein and energy for animal feeding. Sweet potato is widely cultivated in Malawi but mainly for human consumption and there exists a great potential for introducing a new use for the crop as an ingredient in animal feeding. For this trial, four varieties were used and they were evaluated with and without fertilization.

Treatments: four varieties (Mugamba, Sumusa, Kenya and Tainoni)
Planting distance:
Four repetitions, planting date: October 2001.
First harvest: February 2002
Area harvested: 15.6 sq. mt.
Harvest system: ratooning

<table>
<thead>
<tr>
<th>Treatment (Variety x planting distance)</th>
<th>Fresh weight (kg) *</th>
<th>Fresh weight (ton/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mugamba fertilized</td>
<td>65.9</td>
<td>42.2</td>
</tr>
<tr>
<td>Mugamba non fertilized</td>
<td>19.5</td>
<td>12.5</td>
</tr>
<tr>
<td>Sumusa fertilized</td>
<td>39</td>
<td>24.5</td>
</tr>
<tr>
<td>Sumusa non fertilized</td>
<td>31.8</td>
<td>20.4</td>
</tr>
<tr>
<td>Kenya fertilized</td>
<td>56.8</td>
<td>36.4</td>
</tr>
<tr>
<td>Kenya non fertilized</td>
<td>46.8</td>
<td>30.0</td>
</tr>
<tr>
<td>Tainoni fertilized</td>
<td>61</td>
<td>39.1</td>
</tr>
<tr>
<td>Tainoni non fertilized</td>
<td>31.9</td>
<td>20.5</td>
</tr>
</tbody>
</table>

* Fresh weight is the average of four repetitions

- The results obtained in the first harvest were very good. The effect of fertilization was visible for the four varieties (Figures 14 and 15).
- The best variety was Mugamba followed by Tainoni. The amount of sweet potato leaves produced with this variety (42.2 ton) represents a great potential for animal feeding, especially dairy cows.
- The performance of the varieties after the first harvest must be carefully monitored to determine the yield levels during the following harvests.
- If the systems proves feasible and is adopted by farmers, they can find in sweet potato an excellent crop for improving animal feed stuff availability.
- Land O’ Lakes has been following closely this work. If they pick it up, there is a great potential for quick dissemination.
Figure 14. Sweet potato leaves production trial Malawi, ratooning system, first harvest

Figure 15. Sweet potato leaves production trial Malawi, ratooning system, first harvest
4.6. Identification of a Potential Site in Malawi for the Establishment of a Pilot Project

During the visit of the consultancy team to Malawi and Tanzania in October 2001, it was suggested that SARRNET should engage in pilot project activities in both countries, as soon as possible, to gain momentum in the process of promoting a market driven approach for cassava in the region. The pilot project concept is a strategy that has been used successfully by CIAT in Latin America. It is basically the point in which the improved technology for cassava production meets the improved technology for processing under conditions of operation that allow farmers to become familiar with and gain confidence about the technologies being proposed. The products obtained during the pilot phase are used to get private sector enterprises interested in linking partnerships and alliances with the farmers as providers of the products (dry cassava chips or cassava flour). At the same time, the institutions involved in the project design and implement the alliances and interinstitutional arrangements that will facilitate them to provide technical assistance and logistical support to the farmer groups.

The partner that showed some potential to link with SARRNET for the implementation of a pilot project in Malawi is the Christian Service Committee (CSC) of the Churches of Malawi, an international NGO with operations in the country. One of the branches of the CSC operates in the Mulanje area and is closely involved in providing technical assistance and educational services for 2000 households in villages on both sides of the border in Mulanje District. Households comprise of 7-8 members and average land size is 0.2-0.4 ha for Mulanje to 0.4-0.6 ha for the Palombe area. Palombe farmers have some plots across the Mozambique borders. CSC is using Participatory research (PRA) approaches and tools in their daily work.

PRA diagnostics with farmers in various villages have ranked lack of business opportunities as one the most important constraints. In the Mbirima village, for example, problem identification and prioritising exercise gave the following results:

- Declining crop yields (27)
- Limited business opportunities and unprofitable business (20)
- Water (9)
- High disease incidence (5)
- High Adult illiteracy (2)
- Declining tree cover (1)

A proposal was made to CSC to link with SARRNET and discuss the possibility of establishing a joint pilot project activity in the Palombe area. A follow up action agreed upon was to organise a meeting with the farmers in which SARRNET team will bring a power chipper and demonstrate the technology to farmers. Based on the results in this activity and the interest and willingness to participate shown by the farmers, the next step will be to establish a memorandum of understanding with CSC defining responsibilities including budget for the pilot project operations. The initial idea is that SARRNET will provide the equipment (including chipper, drying trays) and improved varieties as well as technical assistance on improved crop husbandry, processing and marketing of produce. CSC should provide technical assistance and backstopping and farmers to provide land and labour.
In November 22nd, SARRNET team accompanied by staff from the national root crops from Bvumbwe Research Station and CSC staff from Mulanje office visited the project area in Phalombe. The objective of the visit was to address the farmers and demonstrate the cassava chipping machine. The meeting took place at Kolowiko Village, Traditional Authority Nazombe in Phalombe District. Over 150 farmers mostly women from Kolowiko, Chimanya, Herema, Bwanali, Haziwelo, Mwazozo, Kachingwe and Kandaya villages attended the meeting. It was agreed that 100 farm families would be selected from the 8 villages to take part in the pilot site activities. One of the criteria for selection of farmers was land availability. It was agreed that only farm families that would allocate a minimum of 0.1 ha to cassava production would be selected for the pilot activities. All the farmers were excited about the idea of producing and processing cassava for income generation especially that the crop does not require a lot of inputs. They however indicated that the major limiting factor would be the availability of adequate planting materials. Farmers requested SARRNET and CSC to provide planting materials immediately as the rainy season had just started in the region.

Farmers also wanted to be assured of the market and prices for the product. They expressed interest to meet some of the potential buyers in the near future so that they could strengthen confidence in the business. It was agreed that some of the industrial consumers should accompany the team to meet the farmers at subsequent visits in future.

After discussions a demonstration of the cassava-chipping machine was conducted. Farmers wanted to know how they would acquire the machine as it looked very useful especially considering the amount of time it takes to process the chips (makaka) using the traditional methods. People looked at this technology as relevant to their needs to reduce time and labour input while improving quality and drying time.

Two critical issues were identified from the meeting and these were: a) identification and registration of farmers to take part in the pilot site activities and b) delivery of planting materials. CSC using its staff based in the area was mandated to visit the farm families and register those that met the selection criteria while SARRNET was requested to start delivering planting materials. SARRNET using its truck started supplying cassava cuttings from Chitedze Research Station, Chiwamba and CSC nursery in Kasinthula on the 27th of November, 2001. Planting materials for Mbundumali and Maunjiri were delivered enough to plant 20 ha. One promising clone (TMS 4(2)1425) was also supplied to be planted on the demonstration plots. SARRNET has also initiated dialogue with Universal Industries, Transglobe and Rab Processors as potential buyers of the products for a possible visit to the area.

During the last visit of the consultancy team to Malawi (May 2002), the pilot site was visited. Some of the observations made in this trip are as follows:

- The site selected for the pilot project is very remote from the main road although there exists a fairly good road access to the farmer village. For example, a visit to the site will mean a 4 hours, one way drive from Blanthyre so that going back to Blanthyre in the same day becomes a very intense journey.
• SARRNET activities have indeed started to make impact in the communities involved. The farmers, with a very strong participation of women are very enthusiastic about cassava.

• Seeds distributed have been planted and are being kept very clean, mainly by the women involved. The team visited several plots and in all of them the crop was looking very healthy, infected plants have been pulled off and in some cases, even mulching practices were being used.

• The agricultural system in the region includes other crops such as pigeon peas, maize, groundnuts, sweet potato and cassava has become the six crop.

• Intercropping with pigeon peas and the use of maize stalks as mulching are creating a very interesting, low input, sustainable system.

• Although cassava is not a new crop in the regions, what is really new for them is the chipping and drying technology which are seeing it with great interest for its potential to become a source of income, a cash generating activity.

• Farmers have experienced in the past the drying technology to produce makaka, mainly for their own consumption and for selling small quantities in local markets.

• CSC as a local partner is collaborating very actively in the implementation of the pilot project.

The consultancy team suggested to SARRNET staff in Malawi to take advantage of the current situation and momentum (shortages of maize, high prices), to conduct a pilot cassava chips drying activity. It could be organized according to the following lines:

1. Chippers—provided by SARRNET, advisable to use two in case one of them breaks.
2. Drying trays—provided by SARRNET, they could be built using locally available. An estimated cost of around 4 dollars per tray was calculated during the visit. Needs to confirmed.
3. Each tray can be built to process around 15 kg of fresh chips so that 70 trays can handle 1 ton every two days.
4. Raw material. Cassava plantings in the village are not yet ready for harvest. Cassava roots can be purchased in the Mozambique border region (around 10 kmts from the site). According to farmers, around 1 Malawian kwacha per kg could be a good purchasing price.
5. The challenge for SARRNET is to facilitate seed money for buying the roots, constructing the trays and running the pilot trial. The product obtained, good quality chips can be sold to Universal Industries that has offered already to buy them. This is a process of learning by doing the technology and building by doing the linkages with the private sector.

Pictures 28, 29, 30 and 31 illustrate some of the aspects mentioned above.
Picture 28. Farmers admiring a cassava chipping machine during the demonstration in Kolowiko village in Phalombe, Malawi

Picture 29. Demonstration of cassava chipping technology

Picture 30. Women group in charge of cassava planting & processing

Picture 31. Cassava as a cash crop in a very intensive farming system
5.0. ACTIVITIES IN TANZANIA
5.1. Information gathered in Tanzania—third and fourth round of contacts with industries, (Oct–Nov, 2001 and May 2002)

<table>
<thead>
<tr>
<th>Organization &amp; Key Persons</th>
<th>Planned follow up activities</th>
<th>Results obtained</th>
<th>Planned activities not accomplished</th>
<th>General comments</th>
<th>Future activities and recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interchick Co Ltd. Po Box 5774 Dar es Salaam Tanzania</td>
<td>Promote the use of cassava and Sweet potato chips and leaves as competitive raw materials in animal feeds.</td>
<td>Experiment 1 Problems with field lay out. Field chosen for the experiment has been used in the past as dump side for chicken manure; thus hiding the effect of the treatment (Picture 32)</td>
<td>Experiment 2 Feed trial:</td>
<td>Development of the experiments was affected by lack of rain. As soon as rainy season sets in field trials will develop and experiments could be continued.</td>
<td>Experiment 1: 1. Discuss trials results and agree on new action plan with Interchick management. 2. Collect previous field monitoring data (score evaluation of stand, pest &amp; disease incidence). Try to recover some reliable data. 3. Improve marking of plots and identification of treatments. 4. Try to select a new plot for a new trial with the upcoming rainy season. 5. For leave production: repeat trial with proper spacing. To be done by: Marianne, Kibaha team and Sicco Experiment 2: Try to get sufficient raw material and install the experiments again. Monitor and document results. To be done by: Dev and Jabal.</td>
</tr>
<tr>
<td>Managing Director Mr. N. Nambiar</td>
<td>Validate and adopt improved production technology for cassava roots and leaves and sweet potato.</td>
<td>Experiment 1: Production plots of cassava and sweet potato using organic manure as a source of fertilizer.</td>
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<tr>
<td>Dr. Ralph Pinto Veterinarian</td>
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<td>Experiment 2: Animal feed trials installed later this year using cassava roots, leaves and sweet potato from experiment 1</td>
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<tr>
<td>Email: <a href="mailto:Interchick@twiga.com">Interchick@twiga.com</a></td>
<td></td>
<td>Experiment 2, Feed trials: Poor results of trial 1 did not allow the installation of this experiment.</td>
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<tr>
<td>Visited: 1st November 2001 Mahungu, Sicco, Bernardo, Julian, Marianne</td>
<td>Experiment 1: tuberisation of SP plants. Spill over of water tank caused water logging in one sector of the cassava trial.</td>
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<td>2. Good development of the plants; some differences are visible although obtaining reliable data will be difficult.</td>
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<td></td>
<td>3. Lack of rain affected tuberisation of SP plants. Spill over of water tank caused water logging in one sector of the cassava trial.</td>
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<td>4. Plant spacing used in cassava leaves experiment was not according to the original design.</td>
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<td>5. Experiment was planted again in 2002 (Pictures 33, 34 and 35)</td>
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Note: This partner has not been as collaborative as expected. Consultancy team suggested SARRNET officer at Dar to drop it. Some data could be taken at harvest time but it will be more interesting to work with new partners that are showing more interest and commitment.
<table>
<thead>
<tr>
<th>Organization &amp; Key Persons</th>
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<th>Planned activities not accomplished</th>
<th>General comments</th>
<th>Future activities and recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malika Investment</td>
<td>Use of cassava and sweet potato chips and leaves as competitive raw materials in animal feeds. Validate and adopt improved production technology for cassava roots and leaves and sweet potato. Experiment 1: Production plots of cassava and sweet potato were installed using organic manure as a source of fertilizer.</td>
<td>Experiment 1 Field trial: Problems with field lay out. Very poor development of the cassava plants was observed. Lack of rain affected tuberisation of SP plants. The experiment on cassava leaves production was not installed. Heavy incidence of Mosaic Virus Disease in parts of the plots. Following the constraints above very little reliable data will come out of the current experiment.</td>
<td>None</td>
<td>Farmer chosen for this work was not very collaborative. His initial commitment and interest soon disappear. He left the country. Collect previous field monitoring data (score evaluation of stand, pest &amp; disease incidence) Identify and plots and treatments in the experiment with sticks and labels. Try to collect some reliable data at harvest time. Document the results. To be done by: Marianne and Vianey.</td>
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<td>Pugu Hills, 25 Km South west of City Centre DSM</td>
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<td>Visited: 31st October 2001</td>
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<td>Mahungu, Sicco, Bernardo, Marianne</td>
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<td>Organization &amp; Key Persons</td>
<td>Planned follow up activities</td>
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<tr>
<td>Prof. C. Kihamia</td>
<td>Use of cassava chips and leaves as competitive raw material in animal feeds. Validate and adopt Improved production technology for cassava roots and leaves and sweet potato. Experiment 1: Production plots of cassava and sweet potato were installed using organic manure as a source of fertilizer.</td>
<td>The consultancy team did not visit the experiment during this trip due to time constraints.</td>
<td>Follow up visit.</td>
<td>Very good contact and collaborator. The use of cassava and sweet potato in animal feeding can be facilitated because he is also a feed producer.</td>
<td>Need to visit this experiment and try to obtain reliable data. To be done by: Marianne and Vianey. If production of roots and leaves is sufficient try to establish a animal feeding trial using the formulations recommended by Julian Buitrago To be done by: Dev</td>
</tr>
<tr>
<td>Plot situated 3 Km north of the Morogoro highway, 10 km west of Ubungo.</td>
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<tr>
<td>Farmers' Millers</td>
<td>Use of cassava and Sweet potato chips and leaves as competitive raw materials in animal feeds.</td>
<td>Experiment 1 Field trial:</td>
<td>Feed trial</td>
<td>Excellent contact</td>
<td>Experiment 1:</td>
</tr>
<tr>
<td>Contact person: Salim Msellem</td>
<td>Validate and adopt Improved production technology for cassava roots and leaves and sweet potato.</td>
<td>Problems with field lay out. And the application of the manure, applied in the rows, not within the lines (Picture 36)</td>
<td></td>
<td>Good farmer and also feed producer (Picture 37)</td>
<td>- Improve marking of plots and identification of treatments.</td>
</tr>
<tr>
<td>The farm is located 10 km south of the intersection road between Kigamboni and the connection with Kilwa road. (25 km south of town using the ferry)</td>
<td></td>
<td>- Difficult to obtain reliable data due to improper manure application.</td>
<td></td>
<td>Willing to invest own resources to get research results and facilitate farmers access to improved technology</td>
<td>- Collect previous field monitoring data (score evaluation of stand, pest &amp; disease incidence).</td>
</tr>
<tr>
<td>Visited: 31st October 2001 Bernardo, Marianne Mahungu, Sicco, May 2002</td>
<td></td>
<td>- Lack of rain affected tuberisation of SP plants.</td>
<td></td>
<td>This farm has become very important for SARRNET as a demonstration effect for donors, policy-makers, farmer groups and private sector (Picture 38)</td>
<td>- Try to recover some reliable data.</td>
</tr>
<tr>
<td>Experiment 1: Production plots of cassava and sweet Potato were installed using organic manure as a source of fertilizer.</td>
<td></td>
<td>- No data collected at harvesting time for Sweet Potato experiment—</td>
<td></td>
<td>The farm can be used as a demonstration effect for both, production technology and animal feeding purposes (Picture 39)</td>
<td>- Discuss trials results and agree on new action plan with local staff and key contact.</td>
</tr>
<tr>
<td>Experiment 2: Animal feed trials installed later this year using raw materials produced.</td>
<td></td>
<td>The experiment on cassava leaves production was not laid out properly.</td>
<td></td>
<td></td>
<td>- Try to select a new plot for a new trial with the upcoming July rainy season.</td>
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<td></td>
<td>Experiment 2 Feed trial: This has not been initiated. Depending on the harvest it will be installed later.</td>
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<td></td>
<td>- For leaf production: repeat trial with proper spacing and fencing of the new plot.</td>
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<td></td>
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<td></td>
<td>- Arrange dried cow manure Proper application of manure Collect samples for soil fertility analysis at IITA Ibadan To be done by: Marianne, Kibaha team and Sicco/Vianey.</td>
</tr>
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<td></td>
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<td></td>
<td></td>
<td>Experiment 2: Try to get sufficient raw material Install the experiments Monitor and document results To be done by: Dev and Salim.</td>
</tr>
</tbody>
</table>
Picture 36. First experiment at Salem's farm, Kigamboni, Tanzania

Picture 37. Salem Msellem has become a highly motivated collaborator of SARRNET in Tanzania

Picture 38. The Minister of Livestock and Water Development of Tanzania visiting Salem's farm

Picture 39. Demonstration of animal feeding cassava leaves at Salem's farm, Tanzania
<table>
<thead>
<tr>
<th>Organization &amp; Key Persons</th>
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<th>Future activities and recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Root Crops Research Program</td>
<td>Validate and adopt Improved production technology for cassava roots and leaves and sweet potato.</td>
<td>Sweet potato experiment has already been harvested.</td>
<td></td>
<td>Research and technology transfer team at Kibaha is giving good support to SARRNET team in Tanzania for implementing project activities (Pictures 42 and 43)</td>
<td>Report on the results of the experiments has to be presented and discussed.</td>
</tr>
<tr>
<td>SRI-Kibaha</td>
<td>Experiment 1: Production plots of Sweet Potato were installed using organic manure as a source of fertilizer (Picture 40)</td>
<td>Data needs to be analysed and communicated.</td>
<td></td>
<td>ilineosiowoqatkekntlanqontsiakeectollrsettin</td>
<td>Discuss new trials related to experiment 1 for the coming growing period with Kibaha team. Need to work out the budget.</td>
</tr>
<tr>
<td>Principal Researcher: Mrs. Kiddo Mtunda &amp; Marianne</td>
<td>Experiment 2. Production plots of cassava leaves with and without fertilizer with two different varieties and different planting distances (Picture 41)</td>
<td>Cassava leaves trial were harvested.</td>
<td></td>
<td>ilineosiowoqatkekntlanqontsiakeectollrsettin</td>
<td>To be done by: Kibaha Team &amp; Sicco.</td>
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<tr>
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<td>If production of roots and leaves is sufficient try to establish a animal feeding trial using the formulations recommended by Julian Buitrago.</td>
<td>If production of roots and leaves is sufficient try to establish a animal feeding trial using the formulations recommended by Julian Buitrago.</td>
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<td>ilineosiowoqatkekntlanqontsiakeectollrsettin</td>
<td>To be done by: Dev</td>
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<tr>
<td>Organization &amp; Key Persons</td>
<td>Planned follow up activities</td>
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<td>Planned activities not accomplished</td>
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</table>
| Tan Dairies                | Validate production technology for cassava roots and leaves and sweet potato.  
Owners:  
Mr. And Mrs. D.K. Mnavi  
P.O. Box 7911, Dar es Salaam, Tanzania  
Tel: 255-22-2461084  
Fax: 255-22-2461090  
E-mail: dag@raha.com  
Principal contact:  
Mr. D.K. Mnavi  
Managing Director  
Chairperson of the Coastal Dairy Farmer Association  
Experiment 1:  
Production plots of cassava leaves were installed using organic manure as a source of fertilizer (Picture 44)  
Experiment 2:  
Animal feeding trials with milking cows, using cassava leaves and roots in the form of silage as the main ingredients.  
Experiment 1  
Experiment 2  | Experiment 1  
Cassava leaves trials have already had the first harvest with excellent results. Yield estimates were around 30–40 tons (Pictures 45)  
Reliable data needs to be analysed and communicated.  
With cassava leaves produced in the experiment 1, silage has been prepared and will be used in the coming months (Pictures 46, 47) | Tan Dairies has the potential to be an excellent partner for SARRNET.  
If the results of the feed trials are good, other dairy farmers will be interested in adopting cassava and sweet potato as ingredients in their animal feeding programs.  
Good partner and site also for validating importance of using organic manure as a source of fertilizer in cassava production. | Obtain data on the agronomic results of the trials, process the information and disseminate the results  
To be done by:  
Kibaha Team SARRNET Team Tanzania  
Collect data and report on the results of the feeding trials that will be implemented, following the recommendations made by Julian Buitrago. |
Picture 44. Cassava leaves production trial

Picture 45. Cassava leaves chipping machine

Picture 46. Silage making with cassava leaves, cassava flour and molasses

Picture 47. Cassava silage in plastic bags
<table>
<thead>
<tr>
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<th>Planned activities not accomplished</th>
<th>General comments</th>
<th>Future activities and recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Odetha Farm</td>
<td>Validate production technology for cassava roots and leaves and sweet potato.</td>
<td>Experiment 1</td>
<td>Cassava leaves trials have already had the first harvest with excellent results. Yield estimates were around 30–40 tons (Pictures 50, 51)</td>
<td>Livestock advisor</td>
<td>Obtain data on the agronomic results of the trials, process the information and disseminate the results</td>
</tr>
<tr>
<td>Owners:</td>
<td>Experiment 1:</td>
<td></td>
<td>Reliable data needs to be analysed and communicated.</td>
<td>Dairy farmer</td>
<td>Collect data and report on the results of the feeding trials that will be implemented, following the recommendations made by Julian Buitrago.</td>
</tr>
<tr>
<td>Mr. And Mrs. J. D. de Wolff</td>
<td>Production plots of cassava leaves were installed using organic manure as a source of fertilizer (Picture 48, 49)</td>
<td>Experiment 2</td>
<td>With cassava leaves produced in the experiment 1, silage will be prepared and used in the coming months.</td>
<td>15 milking cows 105 litres milk per day.</td>
<td></td>
</tr>
<tr>
<td>P.O. Box 2359, Dar es Salaam, Tanzania</td>
<td>Animal feeding trials with milking cows, using cassava leaves and roots in the form of silage as the main ingredients.</td>
<td></td>
<td></td>
<td>Integrated farm: 50 has Vegetables, banana, pastures.</td>
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<tr>
<td>Tel: 255–22–2126118 255–22–2420385</td>
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<td>E-mail: <a href="mailto:jtw@twiga.com">jtw@twiga.com</a></td>
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<td>Principal contact:</td>
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<tr>
<td>Mr. D.K. Mnawi</td>
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<td>Managing Director</td>
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<tr>
<td>Chairperson of the Coastal Dairy Farmer Association</td>
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</table>
Picture 48. Cassava leaves production two weeks old

Picture 49. Good crop development

Picture 50. Cassava leaves trial ready for first harvest

Picture 51. First harvest of 4 months old plants
<table>
<thead>
<tr>
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<th>Future activities and recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karati Animal Feeds</td>
<td>Feeding of cows and pigs with cassava leaves.</td>
<td>Data from these trials will be collected, analysed and disseminated in the coming months.</td>
<td>Main business operation is: Feed mill part time operation Integrated farmer: dairy, poultry, pig.</td>
<td>Planning to plant 4 has of cassava for root production. This cassava will be used for feeding pigs and poultry. Planting material will be suministrated by SARRNET.</td>
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<tr>
<td>Mrs. Machavi</td>
<td>Feeding of broilers with cassava chips.</td>
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<tr>
<td>P.O. Box 5287</td>
<td>Planted 1.75 has of cassava for root production.</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Dar es Salaam</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E-mail: <a href="mailto:amachavi@hotmail.com">amachavi@hotmail.com</a></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.2. Cassava field trials in Tanzania. Initial results

SARRNET activities with field trials initiated in Tanzania in October 2001 with the objective of evaluating the technical and economic feasibility of intensive production systems for cassava and sweet potato leaves and roots for use principally as raw material in animal feeding. These trials have been conducted at the Kibaha experimental station near Dar es Salaam. The field facilities and availability of land in this station as well as the commitment of the personnel that works with cassava and sweet potato represent a great advantage for SARRNET. The results obtained in these trials, if appropriate, could be easily transferred and disseminated among farmers, technicians, private sector enterprises and other parties interested. The facilities in the Kibaha station are ideal for conducting field days, training visits and other related activities. The initial results obtained in the experimental work are presented as follows:

5.2.1. Cassava leaves production trial—Ratooning system

Treatments: two varieties (Kiroba and Kibaha); four planting distances: (0.5 x 0.5) mts and (0.30 x 0.30) mts; two repetitions, planting date: January 2002. Three fertilization methods: chicken manure, cow manure and without manure

First harvest: May 2002; Area harvested: 25 sq.m

Table 10. Cassava leaves trials in Tanzania—2002
Variety: Kiroba

<table>
<thead>
<tr>
<th>Treatment (Variety x planting distance)</th>
<th>Fertilization</th>
<th>Replication</th>
<th>Fresh weight (kg) *</th>
<th>Fresh weight (ton/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kiroba (0.30 x 0.30) m</td>
<td>Chicken manure</td>
<td>1</td>
<td>54</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>47.6</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td>50.8</td>
<td>20.32</td>
</tr>
<tr>
<td>Kiroba (0.30 x 0.30) m</td>
<td>Cow manure</td>
<td>1</td>
<td>14.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>19.5</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td>17.0</td>
<td>6.81</td>
</tr>
<tr>
<td>Kiroba (0.50 x 0.50) m</td>
<td>Chicken manure</td>
<td>1</td>
<td>35.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>39.6</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td>37.4</td>
<td>15.0</td>
</tr>
<tr>
<td>Kiroba (0.50 x 0.50) m</td>
<td>Cow manure</td>
<td>1</td>
<td>15.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>15.2</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td>15.5</td>
<td>6.2</td>
</tr>
<tr>
<td>Kiroba (0.30 x 0.30) m</td>
<td>Without manure</td>
<td>1</td>
<td>14.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>10.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>7.7</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td>13.5</td>
<td>5.4</td>
</tr>
<tr>
<td>Kiroba (0.50 x 0.50) m</td>
<td>Without manure</td>
<td>1</td>
<td>13.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>11.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>16.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>13.6</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td>13.9</td>
<td>5.6</td>
</tr>
</tbody>
</table>

74
Results obtained in this trial indicate that the chicken manure fertilization method was more effective for all the varieties and all the planting distances. There were not great differences between the cow manure and the plots without fertilization. The best treatment was with the variety Kiroba, planting distances of 30 x 30 and the use of chicken manure. Yield levels of 20 ton per ha, after 4 months, are very good. This could be a very reliable intensive production system for cassava leaves that can be used for animal feeding. One of the factors that could explain these big differences in yield is that the plots in which the cow manure was used are very sandy, with very low fertility and subject to water logging. The best yield with the Kibaha variety was obtained with chicken manure as source of fertilizer but with spacing of 50 x 50, which suggests some interaction between the variety and the planting distance.

In general, looking at the soil analysis of the soils in the different plots in which the trials were planted (Table 12), it can be concluded that one of the main constraints to obtain reasonable good yields is the fertility level of the soils. Very seldom, farmers use fertilizers in cassava production and if SARRNET is to make some impact in raising the productivity levels of cassava and sweet potato, some practical, demonstrative work has to be done to show farmers the importance of using fertilizers as one of the main inputs for cassava production. Table 12 presents the results of soil fertility analysis conducted in Tanzania during the 2001–2002 growing cycle.
Table 12. Soil fertility levels in cassava experimental plots in Tanzania, 2002.

<table>
<thead>
<tr>
<th>Location</th>
<th># of samples*</th>
<th>pH H2O (1:1)</th>
<th>Organic C (%)</th>
<th>Kjel N (%)</th>
<th>C/N Ratio</th>
<th>Bray–I P Mg/kg</th>
<th>Exch Na Cmol (+)/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interchick</td>
<td>4</td>
<td>6.95</td>
<td>0.57</td>
<td>0.084</td>
<td>6.7</td>
<td>3.15</td>
<td>0.6</td>
</tr>
<tr>
<td>Salim’s farm</td>
<td>5</td>
<td>5.36</td>
<td>0.096</td>
<td>0.0194</td>
<td>4.96</td>
<td>1.76</td>
<td>0.032</td>
</tr>
<tr>
<td>Kibaha</td>
<td>8</td>
<td>5.4</td>
<td>0.80</td>
<td>0.079</td>
<td>10.15</td>
<td>0.775</td>
<td>0.117</td>
</tr>
</tbody>
</table>

*Values are average of the number of samples in each site

Based on these results of soil analysis the recommendation by the soil fertility specialist at IITA (Joseph Uponi) was:

**Interchick:**
Phosphorus levels are quite low; there will be good response to P fertilizer here. Some Nitrogen fertilizer would also be required. Potassium in the soil is acceptable for cassava production.

*Fertilizer recommendation: 20 kg/ha P2O5 and 30 kg/ha of N*

**Salim’s farm:**
This location has very low soil fertility status. It is very low in organic matter, Nitrogen, Phosphorus and Potassium. Some combination of organic manure and mineral fertilizers would be advantageous here. Green manuring with Mucuna could also be used.

*Recommendation: 30 kg/ha P2O5, 100 kg/ha of N and 60 kg/ha of K*

**Kibaha Research Station:**
The most limiting element in this location is Phosphorus. Nitrogen and Potassium are also on the low side.

*Recommendation: 35 kg/ha P205, 30 kg/ha of N and 15 kg/ha of K*

The recommendation made by the soil fertility specialist at CIAT (Luis F. Cadavid), was as follows:

**Interchick:**
*Fertilizer recommendation: 50 a 80 kg/ha N, localized application at 30 and 60 days after planting 20 kg/ha P localized application 30 days after planting*

**Salim’s farm:**
*Recommendation: 100 kg/ha N, localized application at 30 and 60 days after planting
50 kg/ha P localized application 30 days after planting
80 kg/ha K localized application 60 days after planting*

For this group of soils, green manuring can also be used complementing it with half of the chemical fertilizer.

**Kibaha Research Station:**
*Recommendation: 70 kg/ha N, localized application at 30 and 60 days after planting
50 kg/ha P localized application 30 days after planting
50 kg/ha K localized application at 30 and 60 days after planting*
Figure 16. Cassava leaves production trial in Tanzania, Ratooning system, first harvest

![Graph showing cassava leaves production trial in Tanzania. The x-axis represents varieties and planting distances (meters), and the y-axis represents ton/ha. The bars indicate the production yield with different manure applications.]

- Chicken manure
- Cow manure
- Without manure

Varieties and planting distances (meters):
- Kiroba (30x30)
- Kibaha (30x30)
- Kiroba (50x50)
- Kibaha (50x50)

Figure 17. Cassava leaves production trial in Tanzania, Ratooning system, first harvest

![Graph showing cassava leaves production trial in Tanzania. The x-axis represents fertilization methods, and the y-axis represents ton/ha. The bars indicate the production yield with different fertilization methods.]

- Chicken manure
- Cow manure
- Without manure

Fertilization method:
- Kiroba (30x30)
- Kibaha (30x30)
- Kiroba (50x50)
- Kibaha (50x50)
Figure 18. Interaction Rainfall vs. Yields of cassava leaves in Tanzania, 2002.
(Fertilization with chicken manure)

Figure 19. Interaction Rainfall vs. yields of cassava leaves in Tanzania, 2002
(Fertilization with cow manure).
5.3. Identification of a Potential Site in Tanzania for the Establishment of a Pilot Project

Following recommendations made by the consultancy team in October 2001, and previous authorization by the Coordinator of SARRNET, the team in Tanzania initiated the search for a farmer group and site where to establish a pilot project. It was felt that this initiative could help SARRNET to disseminate the initiatives that are being promoted around the cassava and sweet potato crops. The farmer group selected for the pilot project is located at the village Bungo, 140 kmts south of Dar es Salaam. In this community, cassava is widely grown and is used both as cash and as a food crop. Farmers usually sell the cassava roots at very low prices due to lack of strong marketing linkages. Traders with trucks buy the cassava from farmers in the field.

Processing of cassava is already used in the village in the form of Makopa, the whole dried root. In some cases, traders use the same price for both, the fresh roots and the Makopa, with obvious damage to farmer’s economy. The other processing form used in the village is the production of flour based on fermented roots that are pounded and later dried.

Cassava yields are very good in the region. Estimated made with farmers indicate yield levels of around 12 ton per ha, under a very specific farming system that uses wider spacing and intercropping with maize at 2 meters x 2 meters. Disease pressure for cassava appears to be low according to farmer and agricultural agency officer’s opinions and also the team own observations.

Farmers are organised in small groups at village level and receive good regular training and technical assistance from Agricultural extension workers. Within the next year the district will be connected with a paved road to the capital, Dar es Salaam, a fact that should boost trade and market linkages.

Farm gate prices were estimated in October 2001 at 15-20 Tanzanian Shellings per kg of fresh cassava. (16-21 US per MT). Processing seems feasible considering that it is very common in the village to leave the cassava fields unharvested up to 2 or 3 years due to lack of markets.

The actions recommended in October 2001 were:

- Organise within the coming two weeks a meeting with potential farmer, in collaboration with the agricultural extension agencies, during which SARRNET team will bring the chipping equipment and organise a demonstration.
- Allow farmers to use the equipment, test the product and organise a discussion with the farmers about the potential of this technology in the village.
- Try to come to the meeting with a first approximation of the costs of producing cassava chips using the information provided by the farmers about labour costs, raw material and other costs.
- Get samples of the dried chips to be taken to potential buyers for trials.
- Some weeks later organise a second meeting with farmers to work out a deal on the establishment of the pilot project. This period of some weeks between the two meetings will allow the farmers to have their own discussion and reflections about the potential of this technology intervention proposed by SARRNET.
These plan of action proposed was followed very thoroughly by the SARRNET team in Tanzania and after some months, in March 2002, the pilot site was a reality. The impact of this proposal in the village was tremendous and aroused a lot of commitment and interest among farmers to participate. Recently, a tray drying systems has been built with active participation of the farmer groups and a pilot phase was conducted during which cassava chips were produced and taken to Dar es Salaam to be offered to potential buyers and markets.

What follows now is to complement the processing activities with the introduction of some improved varieties that can be tested by the farmers. Also, once the contacts with the potential private sector enterprises are defined, the processing activities at pilot site can be strengthened and, if necessary, increased in scale.

The pictures in the next page illustrate some of the activities conducted in the pilot site at Tanzania.
Picture 52. Cassava drying system at Bungo village, Tanzania

Picture 53. Good cassava root yields at Bungo village

Picture 54. Demonstration of chipping and drying technology

Picture 55. Farmers at Bungo village building storage facility and testing tray drying of cassava chips
6.0. SARRNET Staff Scientific Exchange Mission To Latin America
February 24th–March 10th, 2002

Trip report

6.1. Introduction

SARRNET (Southern Africa Root Crops Research Network) and the International Center for Tropical Agriculture (CIAT) initiated a collaborative effort aimed at re-orienting SARRNET activities towards a market driven strategy for cassava and sweet potato research and development activities. The first meeting between SARRNET, IITA, SARRNET, CIAT and CLAYUCA (Latin American and Caribbean Consortium to Support Cassava Research and Development), scientists took place in Malawi in November 2000. After the Malawi meeting, several visits by CIAT/CLAYUCA staff were made to the SARRNET region to assist the SARRNET team in the implementation of the new strategy.

One of the activities proposed was to organise a scientific exchange tour for SARRNET staff to Latin America to allow them to get a first hand knowledge of cassava production, processing and commercialisation experiences in Colombia and Brazil. Special emphasis was put on reviewing the public-private sector partnerships (PPP) established by CLAYUCA with local partners.

This scientific exchange study tour was undertaken during the period 24th February to 10th March by a SARRNET team that included:

- Dr. N. M. Mahungu (SARRNET Coordinator, based at Malawi),
- Sicco Kolijn (SARRNET Post-harvest Scientist, based at Tanzania),
- Vito Sandifolo (Integrated Projects Officer based at Malawi).

The team would like to thank especially Mr. Bernardo Ospina and his CLAYUCA team for organizing this very interesting and useful visit to Colombia and Brazil. Thanks as well goes to all the local organisers in Colombia and Brazil who accompanied us during all the field visits to private companies, farmers, research institutes and researchers who received us and shared their experiences and ideas with us. The Team would also like to thank the SARRNET donor, USAID for providing the funds and approval to undertake this trip.

N. M. Mahungu
S. Kolijn
V. Sandifolo
## Table 13. Travel schedule and places visited

<table>
<thead>
<tr>
<th>Day</th>
<th>Date</th>
<th>Place</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td>Monday (25/2)</td>
<td>Arrival at CIAT/Cali 23:00 Arrival Vito Sandifolo and Sicco Kolijn</td>
</tr>
<tr>
<td>Day 2</td>
<td>Tuesday (26/2)</td>
<td>Visit to CIAT Research Departments Visit Acting DG and Directors Visit Germplasm Bank &amp; in vitro collection Visit IPM Unit Visit Biotech team Meeting with CLAYUCA team Visit tissue multiplication work at CIAT,</td>
</tr>
<tr>
<td>Day 3</td>
<td>Wednesday (27/2)</td>
<td>Arrival Dr. Mahungu via Sao Paulo–Bogota Visit to Pig farm Granjas Paraíso Visit Nutribal (Palmeira) Visit Cavasa Meeting CLAYUCA team, various presentations and tour of processing plant for cassava flour, student projects on cassava starch.</td>
</tr>
<tr>
<td>Day 4</td>
<td>Thursday (29/2)</td>
<td>Presentation Cassava breeder (H. Ceballos) Visit commercial cassava root farm (30 MT/ha) Visit two sour starch enterprises Visit CIAT Agro–Enterprises Development Project</td>
</tr>
<tr>
<td>Day 5</td>
<td>Friday (1/3)</td>
<td>Visit to Armenia Visit cassava demonstration plots at SENA, Buga Visit paraffin coated cassava roots Visit cassava roots farm (35 MT/ha)</td>
</tr>
<tr>
<td>Day 6</td>
<td>Saturday (2/3)</td>
<td>Visit KOPLA (cassava croquettes factory) Return to CIAT–Cali Departure Dr. Mahungu for Sao Paulo</td>
</tr>
<tr>
<td>Day 7</td>
<td>Sunday (3/3)</td>
<td>Departure from CIAT (V.Sandifolo, S. Kolijn and B. Ospina)</td>
</tr>
<tr>
<td>Day 8</td>
<td>Monday (4/3)</td>
<td>Arrival Sao Paulo Airport Transfer to Novotel Campinas</td>
</tr>
<tr>
<td>Day 9</td>
<td>Tuesday (5/3)</td>
<td>Visit to ARI headquarters (met Dr. Lorenzi) Visit flour processing farm/enterprise (human consumption) Transfer to Assis Diner meeting with Director starch factory (Antonio Fadel)</td>
</tr>
<tr>
<td>Day 10</td>
<td>Wednesday (6/3)</td>
<td>Visit starch factory and cassava production fields (30 MT/ha, 2000 ha) Cooperative of cassava producers and press meeting Visit Gabi (tempered cassava flour for human consumption) Visit of farm with cassava leaves silage for beef production</td>
</tr>
<tr>
<td>Day 11</td>
<td>Thursday (7/3)</td>
<td>Visit to ARI Assis research station; tour cassava fields Visit cassava processing cooperative (flour &amp; frozen) Return to Novotel Campinas</td>
</tr>
<tr>
<td>Day 12</td>
<td>Friday (8/3)</td>
<td>Visit University and Food Technology Institute, Transfer to Sao Paulo Airport Departure Sandifolo and Kolijn for Amsterdam</td>
</tr>
<tr>
<td>Day 14</td>
<td>Sunday (10/3)</td>
<td>Departure Mahungu for Mozambique via Johannesburg</td>
</tr>
</tbody>
</table>
6.2. Activities in Colombia

6.2.1. Visit to CIAT

A courtesy call to the acting director was the first activity undertaken by the SARRNET team. Three directors, (Dr. Aart van Schoonhoven, Acting Director General, Dr. Raphael Posada, International Cooperation Director and Dr. Jesús A. Cuéllar, General Administrator, were briefed by Bernardo Ospina (CLAYUCA Director), Sicco Kolijn and Vito Sandifolo (SARRNET) about the objectives and expectations of the trip as well as how the IITA/CIAT collaboration was progressing in the SARRNET countries. The discussions indicated that the IITA/CIAT collaboration had started showing positive impacts in SARRNET countries such as Malawi and Tanzania where market oriented research and development activities had been initiated. The Acting Director General kindly requested to share this tour report with him and his colleagues.

Visit to the Genetic Resources Unit

A visit was made to the Germplasm Bank and in vitro collection where the team was briefed about the strategies used to maintain the germplasm bank for cassava, beans and pastures for future breeding work. This unit is important for the commercialisation of any crop since it allows breeders to go back and get germplasm or sources of required traits for the market. The unit had 700 spp of beans and 6000 accessions of cassava either in the short term and
long-term storage. The short-term storage entails storing the accessions in cold rooms for a period of about 20 years while long storage goes for over 100 years.

Visit to Biotechnology Unit

The team paid a short visit to the Biotechnology unit to learn more about cassava BioTech activities. The BioTech team considered itself basically as a Research Support Unit that provides technical support to other units within CIAT. This involves getting together with the breeders and IPM unit. Another task is to identify and adopt molecular markers and other new research tools to keep on upgrading its research capacity and conduct bio safety research. However, the unit has also developed a number of activities on its own, such as the rural based tissue culture labs which should assist farmers with the multiplication of pathogen-free planting material of wide range of crops.

The team highlighted the following list of cassava research projects at CIAT of interest to Africa:

1. Anti-sense down regulation of GBSS I gene for the production of waxy cassava starch. Normal cassava starch contains around 83% amyllopectin and 17% amylose. The aim is to get cassava varieties with <1% amylose as it is a much more stable cassava starch. Because of this branched structure, amyllopectin delays or prevents gel formation, and retrogradation is slower than with amylose. Up to now this process to obtain a 100% amyllopectin cassava starch variety is patented by a Wageningen based research group and will be commercially utilised by the Dutch based AVEBE Starch Company in Indonesia. It would be interesting to re-invent this process within the CGIAR network and make it available to more cassava starch factories worldwide to boost the commercialisation of cassava further.

2. Gene tagging and marker-assisted improvement of resistance to cassava mosaic disease (CMD), cassava bacterial blight (CBB), white fly resistance and early bulking.

3. Genetic diversity assessment of cassava land races from its primary and secondary centres of diversity.

4. The Advanced Back Cross (ABC) QTL mapping scheme for the identification and introgression of favourable alleles for high protein and dry matter content from wild relatives.

5. Rudimentary tissue culture multiplication of improved varieties for disease- and pest-free planting material. The team visited a prototype rural-based tissue culture multiplication facility at CIAT. Later on, the CLAYUCA team presented a larger scale cassava tissue culture multiplication scheme (see pictures).

6. Development of a new breeding scheme based upon inbred line extraction and inter-population improvement.

7. Development of a web-based cassava diversity and genome databases, for public access and genetic diversity, molecular market data and phenotypic data generated during the course of genetic diversity and mapping projects.
**People met:**

Zaida Lentini, Martin Fregene, Paul Chavarriaga and Roosevelt Escobar.

**Presentation of cassava breeding program at CIAT**

The team attended a presentation on the modification of cassava breeding scheme proposed by Dr. Hernán Ceballos, the current CIAT cassava breeder. The modification of the conventional scheme had become necessary because cassava is now playing a double role of being a food crop as well as an industrial crop. Therefore it is not possible to come up with a double purpose variety, as the performance of a dual-purpose variety will be mostly a compromise for both clients and therefore will never be a champion. If cassava serves a dual-purpose crop, farmers always tend to go for the more attractive fresh market and forget about supplying any industrial user. The new emphasis of the breeding work is to develop varieties for each market.

Problems of the conventional evaluation scheme are that large selections are based on data taken from a single plant. No data is taken in the early stages of selection as a result some good varieties are lost to the scheme and it takes long time to start having replicated trials.

The new scheme enables first selection based on 7-8 plants and data would be recorded on all traits for 2 locations. The evaluation period would also be reduced and varieties would be produced for specific products/market and environments. The breeder explained the principles of the new breeding scheme and the effect of shelving (eliminating deleterious genes) to capture genetic superiority.

Dr. Ceballos mentioned as well that varieties with leaf retention capacity (to the lower parts of the stem) imply an additional 7 MT/Ha fresh roots (based on evaluation of various cultivars).

**Other relevant supporting departments at CIAT**

Visits were made several departments that promote, strengthen and sustain production and commercialisation of any crop at CIAT. These departments included:

- Integrated Pest Management Unit for control of pests and diseases. Staff met: Elizabeth Alvarez, Anthony Belloti and John Locke.
- Rural agro-enterprises development group (Mr. Carlos Ostertag). During this meeting the team exchanged ideas about how to set up sustainable and commercial agro-enterprises like for starch, feed and flour in Africa.

**Presentations by CLAYUCA Team**

The CLAYUCA team made several presentations about the following subjects:

- Fertilisation and mechanisation for cassava production (Ing. Luis Fernando Cadavid)
- Cassava foliage for feed utilisation (Mr. Bernardo Ospina and Diego Rosero (Student).
Visit to the pilot processing plant for flour production for animal feeding applications (this unit processes fresh tubers into dried flour form).

Visit to cassava rapid multiplication and hardening unit.

Most of the information was provided on a CD-rom with all the data of the research trials and findings.

The presentations centred on results of work done by CIAT and CLAYUCA. The results indicated that cassava planting and harvesting could be improved through mechanization. For instance, for mechanised planting, two different tractor driven planters are now on the market: one planting double row and the other three rows. The minimum spacing of the mechanised planter is 40cm between 2 crop lines and can plant up to 1 Ha/ hour. The advantage for the double row system is that the tractor cuts the cassava stems into cuttings of 25–30cm long on its own and throws away the last part if it is too short.

The studies also showed that using the semi–mechanized harvester, the cost of harvesting could be reduced considerably as 1 person could harvest now up to 700–900 kg/man–day opposed to 300 kg/man–day by hand. In Brazil it is normal to find efficiencies of 1–1.5 MT/man–day.

The soil fertility studies indicated that management practices such as mulching, tillage, and fertilization have an effect on root and leaf yield. Quantities used depend on the soil conditions and requirements of the plant. Studies on leaf production demonstrated that varieties respond differently to ratooning. Spacing has an effect on leaf yield. However, the best spacing is the one that gives more yields while allowing easy field operations. The CLAYUCA team has planted cassava in its latest leave trials in 70x40 cm spacing, allowing the tractor to pass through the row for mechanical harvesting. A 30x30 cm, recommended by CLAYUCA last year and used in Malawi and Tanzania, does not allow mechanical planting and harvesting. Yields in this new configuration will be consequently lower but is a compromise between cost of production and the benefits.

6.2.1. Field visits in Colombia

Visit to pig farm (Granjas Paraíso)

This pig farm, based 10 km from CIAT HQ, is a collaborator of CLAYUCA for animal feeding trials using cassava on a commercial scale. This approach allows CLAYUCA to generate reliable data, which is then used for sensitisation and demonstration purposes.

The farm uses an “all in all out” continuous system to control disease. The farm had 74 breeding sows, which provide piglets after furrowing for finishing. The sows are selected from the stocks available at the farm. Furrowing is synchronized so that piglets can be shared amongst sows. By using hormones for this purpose the mortality rate was lowered from 20–25% to less than 10%. Current pork meat prices in Colombia are 3250 Pesos per kg and the average consumption per capita in Colombia: 4 kg pork/year.

A feed experiment was conducted using a control feed (corn 40–45%, Soya 20–25% and Wheat bran) and a cassava based feed (replacing the corn with cassava). There were in total 4
groups of 12 pigs each. Results showed that there was no difference on feed intake between the cassava based ration and the control/commercial feed. The animals fed from the two rations also attained final weight between 100 to 105 kg within the same period. This indicated that cassava based meal was as good as the commercial feed in terms of feed intake and weight gain. The farmer and researchers could not tell us the final gain by using cassava chips in the feed. Unfortunately the pig farm is not situated in a production area of cassava and therefore it is most unlikely that this farmer will ever adopt cassava chips in the feed formulation.

The owner of the farm told us that Colombia has got a National Pork Producers Association, which tries to promote the production and consumption of pork in the country. This national body receives funds from a national levy on pigs (1 Pesos/pig) and conducts specific research and promotion activities. With 7 other pig farmers, the farmer is organised in a local group around Cali. This producer groups shares practical production information, genetic resources to improve the breeding capacity, imports semen provides artificial insemination and works on the marketing aspects of pork in the region.

Visit to animal feed factory

The team also visited Nutribal, the feed mill co-owned by Dr. Julián Buitrago. Mr. Buitrago, the animal feed consultant working with CLAYUCA, showed the team the processing plant including the palletising plant, the roasting of Soya beans and a new drying tent for drying feed ingredients (build out of bamboo construction material). The factory also produces pet food and will soon start the production of molasses-mineral blocks for cattle. Nutribal is a stakeholder of CLAYUCA.

Cassava multiplication and leaf production trials at Cavasa

A visit was made to a cassava leaf production trial near a big slaughterhouse in Cavasa, 30 km from CIAT, where CLAYUCA is conducting cassava multiplication and leaf production trials using materials from its tissue culture multiplication facility. The plot had only been harvested once and will be harvested every three months. The team observed a very healthy crop.

Visit to commercial cassava farm near Cali

A visit was made to a commercial cassava farm in Agrovélez where Mr Arberto Haman, the agronomist of the company was met. He stated that the farm was previously growing soybean but diversified to cassava because soybean was getting less profitable. The initial objective was to produce cassava for starch extraction but this idea was dropped as the fresh market was more lucrative. About 19 varieties are grown on the farm including improved varieties developed at CIAT through CLAYUCA. The farm is 200 ha and produces yields ranging from 32–55 tons per ha. For the production of cassava the farm uses fertiliser (100 kg of Potassium, 10 kg Borax and 40 kg of Zinc Sulphate) applied after planting. Herbicides (application 1 MAP, 35 grams/mixture, last for 45 days, side dressing) are used pre and post planting. Mechanical weeding is done 60 days after planting. Total production cost (including harvesting): 1100 USD/ha.
People trained to identify infected plants eliminate them during the harvesting of the tubers. Harvesting is done manually and roots are graded before being taken to the market. Bottle type roots are preferred on the fresh market and get a price of 180 pesos. (about US$0.08 per kg). The lower grade roots are sold to starch factories at an average price of 150 pesos (about US$0.06/kg). Supermarkets are a much more attractive market as they offer up to 700 pesos/kg (about US$ 0.35/kg) for quality tubers although they don’t buy in large volumes. The average net income per ha for this cassava farmer could be estimated at 2100 USD.

However the farm experiences an increasing problem with pests and diseases. The major problem is white flies that suck plants resulting in a fungus. The company has tried to control the white fly populations by spraying with chemicals such as Cypamethrin but the results have been poor. The whitefly problem is so acute that the farm will have to be rotate with other crops about 2 years to allow the whitefly population to go down. The farm also sells planting materials to other farmers.

Visit to small scale sour cassava starch processing plants (Mondomo, Cauca)

The team visited two small-scale sour cassava starch-processing plants in Cauca and Mondomo, both producers of sour cassava starch for baking the traditional cassava bread. Both companies are situated in a mountainous, humid area with good conditions for cassava starch processing. There is adequate clean water available in the many small rivers running down from the mountains and cassava is widely grown for commercial purposes. Most of the starch producers are now organised in a producers/marketing association to improve the sales and distribution of their products. One major threat could be the cheap importation of native cassava starch which is converted into sour starch. Another tread is the continuous pollution of the downstream main river with the effluents of the many processing centres along the river.

The first plant visited was a traditional type that used a single electric motor to drive all processing applications (peeling, grating, sifting and pumping of water). The capacity was 3 tons/day and the limiting factor for expansion was lack of drying space for drying the fermented sour starch.

The plant layout includes a receiving area where fresh roots are collected and weighted, a peeling unit, a grater, mechanical sieves, sedimentation channels and fermentation tanks. The operations from cleaning to sieving are done mechanically using one electric motor and some pumps.

The second plant, which belongs to Dr. Martin Moreno, a Professor at the University of Valle in Cali, was a modified version of the first one where instead of using one electric motor, several of them are used to run the processing unit. The processing is further facilitated through gravity as the processing is following the slope of the terrain (this cuts out the need for elevators, pumps and/or manual labour). Basically the machines are similar (although the peeler looked modified) and just 2 people can operate the entire plant.

The main by-product, fibres, is used to feed pigs within the same compound to increase the profitability of the entire processing unit. Dr. Martin Moreno is one of the co-authors of the
book of Cassava Sour Starch in Colombia; a publication by CIAT, CIRAD, University of Valle and CETEC.

Some basic figures of the starch operation, small-scale, are as follows:

The capacity for both plants was about 3 tons/day and the sour starch is sold to bakeries in the city of Cali for making cheese bread and other products. The sales prices range between 1500 and 2500 Pesos/kg (600–1100 USD/MT) depending on the quality of the sour starch. The average extraction rate is 20–25% from fresh cassava roots. One of the major factors considered in starch extraction is water availability. About 12 cubic metres of water are required for 1 ton of dried starch. The water is obtained from small mountain rivers, a few hundred meters upstream (each starch processor has got a pipe up into the mountain). As the area receives rainfall throughout the year the production can be done continuously. However, due to the increased pollution of the rivers with effluents (water from the starch factories), the law does not allow any longer the development of new starch factories in the area.

The team visited in a local metal workshop that manufactures and maintains starch-processing equipment. This small-scale metal engineering workshop is able to make a range of processing equipment (like washer/peelers, motorised graters, fibre/starch separators and screening equipment). The owner showed a new fibre separator based on the models used in Brazil. This innovation is facilitated through the support offered by the University of Valle, the CIAT Rural–Agro enterprises development group and CIRAD.

Cassava leaf production & silage-making trial at SENA

On the way to Armenia the team paid a short visit to ENSA School of Agriculture in Buga (Vocational Agricultural Training Institute with branches all over the country). The school teaches students in agricultural technologies and also collaborates with CIAT and CLAYUCA in conducting field trials on cassava (root and tuber) production and utilization as silage.

A cassava leaf production & silage-making unit were visited. The crop was planted at 30cm x 30cm in the cassava leaf production trial and two harvests had already been done. Twenty tons of leaves fresh weight were obtained during the first harvest but this dropped to 14 tons during the second harvest (harvest in dry season). One part of the plot was not ratooned to allow assessment of effect of ratooning on root yield. Fertilizers with N and K were applied but no P because the soils in the area were already rich in P.

Both roots and leaves are used in making silage for dairy animals at the institution using cassava leaves (30%), roots (60%) and molasses (10%). Leaves provide protein, while roots provide carbohydrates and molasses enhances the palatability of the silage. The protein level of the silage was around 20%, 14% crude fibre and some ashes. Preliminary feed trials indicated that 2 additional litres of milk were obtained per animal with the silage (around 10% of the live weight of the animal is fed daily).
**Paraffin coated cassava roots**

*Cassava Special E.A.T.* is one of the many small-scale factories that process cassava and plantains into snacks. The factory also practices paraffin coating of fresh roots (*Yuca Parafinada*) to lengthen the storage life. Fresh roots are washed, disinfected using *Lonlife 20%* (use of 20 cc per 10 MT of fresh product) and left to dry. These are then coated with paraffin and transported to markets in Cali and Bogotá for sales in supermarkets and retail shops. These roots can stay for 2 months without getting spoiled.

Due to increased health and environmental concerns, mainly in export countries like USA, Japan and Europe, the company is currently testing and developing a new waxing method using a biodegradable material. With the help of SENA Armenia the company is testing the use of pine resin (tar), which was obtained in Canada.

Paraffin coating has to be done at a temperature of 150 degrees Celsius and uses around 3.8 gram per root of wax. Pine resin can be done at 60 degrees Celsius (which is causing a much less temperature shock to the root). However recent tests prevailed that the resin turned to be much thicker as coating and requires around 10 grams per root. The price of the paraffin is 526 USD/MT while the imported pine from Canada costs 5 times the price (2600 USD/MT).

This is a price increase of more than 13 times compared with the paraffin wax. The export market requires a bright coating. Average price of fresh cassava: 250 Pesos/kg. Sales price of waxed cassava: 500 Pesos/kg (.27 USD/kg).

Apart from the waxed cassava roots, the company produces also crisps from plantains and cassava. For the cassava crisps, fresh roots are peeled and put in water to reduce the starch content. The soaking period depends on the starch content of the cultivars. Alternatively the crop is ratooned 1 week before the actual harvesting of the roots. The roots are then washed, sliced (150 kg/person/day), fried in palm oil at about 190–200 degrees Celsius and packed in various bag sizes. The owner of the company produces some of the cassava roots within his own farm (15 ha). Additionally, he gets cassava from 200 ha from contract–farmers. The average yield is 30 MT/ha on his farm. The company can process about 4 tons crisps per week but had temporarily stopped at the time of the visit.

Apart from processing the company co–funds and conducts research on new varieties in collaboration with CLAYUCA and SENA. CLAYUCA provided improved varieties developed at CIAT while SENA provides technical information through their technician based in Armenia. Attention is being paid to the size of the roots and storage period. The markets are demanding good–sized roots that can stay for over three months after paraffin coating or waxing using resins. Several private sector partners pay a small contribution to SENA to conduct specific research and provide technical assistance in product development and market testing.
Visit to commercial cassava farm in Quimbaya (50 km west of Armenia)

A visit was made to a commercial cassava farm that produces for the fresh market. The owner of the farm Mr. Cesar Bedoya, used to grow just coffee on his estate but has started growing cassava (intercropped with maize and coffee) because the current world market prices of coffee. He now grows 35 ha of cassava using organic manure (composted chicken manure) at the rate of 1.4 MT/ha (=200 grams/plant) and practices biological control for some soil borne diseases. Harvesting is done 11 months after planting. The average production costs are US$ 1100 per ha with a mean yield of 35 ton/ha (cassava was selling last year at 850 Pesos/kg). Cassava is intercropped with maize at a plant population of 7,000 plants/ha for cassava. Two rows of cassava are planted between rows of maize. The average yield of the maize is 4 tons/ha in this association. The major problems are fruit flies and root rot.

Visit to Kopla Croquette manufacturing company

Kopla produces croquettes from cassava and plantain and supplies its products to supermarkets in Armenia, Cali and Bogotá. The company started the business 7 years ago although the factory was rehabilitated after the earthquake 3 years ago. The processing plant comprises the receiving area where fresh roots are collected and peeled. The peeled roots are kept in water to reduce oxidation up to the times that are taken for slicing. After slicing the roots are boiled in water, frozen and later minced in frozen form into a mash using a kind of minced meat grinder. Afterwards salt is added in a horizontal mixer (homogeniser) and then inserted into an extruder type of machine to shape the croquettes. The croquettes are dropped on a plastic conveyor belt and lifted to a hot oil bath for frying. The frying is done in a soya/palm oil mixture of 180 degrees Celsius for 40 seconds. After cooling down for 20 minutes, the croquettes are deep-frozen to–12 degrees Celsius. The next day the croquettes are being packed in frozen form and distributed to various customers. Each bag of 1 kg contains 32 croquettes. Kopla packs its products under its own brand as well as packs for supermarket chains under other names.

Plantain cakes are the second product of Kopla. Green plantain is peeled, selected and soaked for one night. Then the plantain is chopped in 6–7 cm long pieces and deep-fried for 4 minutes in a similar oil mixture. Once the chops start floating the pieces are removed out of the oil bath and put under a press to make small pancakes shaped pieces. These pieces are then frozen en packed, just like the cassava croquettes.

The capacity at the factory is around 1.5 MT of cassava croquettes/day while plantain snacks can be produced at 500 kg/day. The processing equipment was all designed and constructed locally by the owners. The estimated cost of the entire factory is around 70,000 USD (including the freezers of 10,000 USD each). Demand on the market varies from time to time. Currently the lack of demand is the limiting factor to expand the production. Therefore the company is exploring export opportunities (mainly USA/Miami and Japan). The processing efficiency is 65% for cassava (1 MT fresh will give you 650 kg of croquettes) while the conversion factor of plantain is far less; 30%. Prices are 2300 pesos for kg of cassava croquettes (around 1 US$) and 3000 pesos for kg plantain cakes (around 1.3 US$).
6.3. Visit to Brazil

*Instituto Agronómico de Campinas–IAC, Campinas*

The visit to Sao Paulo State in Brazil took place from the 4th to the 8th of March 2002. Dr Bernardo Ospina of CLAYUCA and Mr Humberto Guzman of Ministry of Agriculture of Colombia, Department of Research, Bogotá accompanied the SARRNET team. The Instituto Agronómico (IAC) of Sao Paolo State, whose headquarters are located in Campinas, hosted the team during its stay in Brazil. The team paid a courtesy call to the office of the Director of IAC and met Dr. J. Osmar Lorenzi. He welcomed and briefed the team about the program for the visits in Brazil. The visit included visiting research fields, commercial farms, various processors and users of cassava products. IAC is one of the 6 Agricultural Research Institutes funded by the Sao Paulo State Government.

Dr. Jose Osmar Lorenzi has been a very active cassava breeder for many years and accompanied the team during the first part of the visit. During the rest of the visit in Assis, Dra. Teresa Losada Valle accompanied the team and was assisted by Dr. Ricardo A.D. Kanthack. The team mainly concentrates its research efforts on cassava and Irish potato, as they are the most popular root and tuber crops in the state. Sweet potato is only grown as a vegetable and the institute keeps only a collection of various local cultivars.

*Visit to Invicta farm/factory in Araras*

*Invicta* is one of the cassava flour processors who have been in the business for over 50 years. Apart from processing cassava flour, Invicta runs a 600 ha farm with a number of different crops (citrus, maize, soybeans) and keeping beef cattle. Cassava is grown on over 150 ha every year using mechanized planting and harvesting.

Cassava is planted on ridges at the spacing of 1 metre between ridges and 60cm between plants. Herbicides such as Dual and Paraquat are applied after planting. Fertilizers are also applied at the rate of 0 nitrogen, 20kg phosphorous and 20kg potassium per ha. Nitrogen is not applied because the soils are already having adequate supplies since cassava is rotated with maize. On average 30 to 35 tons are produced after 18 to 24 months of growing period. Apart from planting cassava for the factory, which is based at the farm, Invicta also, multiplies clean planting materials supplied by IAC from its tissue culture facilities to reduce build up of diseases through recycling of planting materials. All the cassava produced is processed at the farm factory. According to the farmer the cost of producing 1 ha of cassava is 1000–1100 USD (including harvesting). Mechanical lifting of the cassava tuber (using a tractor) has reduced the cost price of the cassava dramatically and makes its possible to produce cassava flour at a competitive price.

The main product for the factory is flour although by-products such as starch and animal feed are also produced. The whole process of flour production (from washing of the roots to flour extraction) is mechanized. The process involves washing of the roots, grating it into a mash, squeezing the mash to remove water, artificial drying using rotating pan fryers with fire underneath, grinding and sieving and packaging into 40kg bags. The grating capacity is around 4 MT/hour while the 4 presses (operated by 2 men) can handle around 6 MT/hour using 2 hydraulic jacks. The factory operates under normal circumstances 10–12 hours with 9
people in the factory. The sales price of 1 bag of 40 kg is around 7 USD (175 USD/MT of flour). The processing efficiency rate is 3 MT of fresh roots to 1 MT of flour. The cost of labour (worker) can be estimated at 8–9 USD/day. The factory produces around 1,2 MT of flour per hour.

Fibres and peels are used as animal feed while starch from water after squeezing is collected in tunnels outside the factory building. After sedimentation of starch, the water is collected in a basin and from there it is transported using water tankers for irrigation in new cassava fields. The factory is facing new challenges since consumers are requesting cassava flour with additives such as spices (tempered flour) and they are considering this option to include it as an additional step in processing. The farm is also testing new clones of cassava supplied by IAC.

Visit to Halotek–Fadel Industry LTDA in Assis

Halotek–Fadel Industry produces native and modified starches as well as derivatives from starch such as dextrin and adhesives from cassava. The company has been in the business of processing starch from cassava since 1975. The company produces fresh cassava on its own as well as in rented land (around 1000 ha) and also purchases fresh cassava roots from out-growers (last year 4500 ha), located in an area 100 km around the factory. Last year, the factory processed a total of around 90,000 MT of fresh roots.

Every year the factory establishes a production and supply plan of cassava with its out-growers and own production team. The contract with the out-growers includes a minimum price and delivery date to the factory. The factory also provides technical assistance to its out-growers through advices on soil analysis & fertilisation, crop management and varieties.

The team visited one of the Halotek’s rented cassava fields in which 400 ha and 7 varieties were planted. Local varieties were preferred because they were high yielding despite being susceptible to pests and diseases such as cassava bacterial blight. Planting is done on the flat at 1m within rows and 75cm between plants. Both planting harvesting are done mechanically. Fertilizers and herbicides are applied. Yields ranging from 30–35 tons per hectare are obtained after 18 months of plant growth (planting is done in the colder periods of the year; May and October). The average production costs are $16 per ton of fresh root after 18 months and $18–20 per ton after 12 months of plant growth.

The starch-processing factory is highly mechanized from washing of roots to modification and packaging of the native and modified starches. The process involves receiving fresh cassava from the field by truck, washing it using recycled water, chipping, grinding, mixing with water, sieving and fibre and starch separation, and drying though a flash dryer to obtain native starch. The production capacity is around 18 MT of fresh roots/hour (300 MT/day). This part of the factory operates currently 20 hours/day due to the fact that during the evening hours (18–22 pm) the electricity prices are 4 times higher the normal price (due to the electricity crisis in the country).

The company has over the years expanded its operations into the production of various modified starches for specific markets. This is through a strategic alliance with National Starch & Chemical Industrial Ltda., which is a member of the multinational ICI group.
Modified starches include pre-gelatinised starch for toilet paper production, liquid modified dextrin and cationic starch. Recently a new press was installed behind the factory to refine further the fibre pulp, which is a by-product of the native starch-processing factory. In the past the fibres were given away to cattle farmers as a feed-ingredient but now the factory is transforming it into a flour that can be used for mineral extraction.

Mr. Antonio D. Fadel, the owner of the factory is also the chairman of the Brazilian Cassava Starch Manufacturing Association (Associacao Brasileira dos Productoes de Amido de Mandioca ,www.abam.com.br). According to him, Brazil is now producing around 550,000 MT of starch/year and he predicts that within the coming 3–4 years this figure will increase up to 1,000,000 MT. This figure is based on the worldwide increasing demand for starch, the strategic location to Europe and USA market compared to the Thai suppliers, the domestic demand for starch as ingredient for baking products and the competitive prices for cassava production that they are obtaining in this region of the Brazil. Right during our visit there was an important meeting with the government to discuss a law that should impose the baking industry to gradually include cassava flour/starch in bread products. This new law could boost the entire cassava production and commercialisation within Brazil and reduce the volumes of imported wheat grains.

After touring the factory, the team held a meeting with the two directors of the company Mr Halotek and Mr Fade to discuss future plans for the factory and possible investment plans in the SADC countries in Africa. The two expressed interest to go into partnership with other interested parties in Africa. They indicated that they had the technology for starch production and would be interested to join hands with someone who could have money and land to produce the cassava and install the machinery. A native starch factory with a capacity of 200 MT/day would cost around 1,000,000 USD.

The SARRNET Coordinator expressed interest to invite on of them to the 2002 SARRNET Steering Committee to take place end of April in South Africa to enable them interact with potential investors in the starch business. This participation of the Brazilian cassava producing and processing private sector in this meeting was finally realized and the Steering Committee had the chance to interact with these innovative entrepreneurs.

Visit to the cassava producers association of Sao Paulo State

The team met briefly the chairperson of the cassava producers Association in Sao Paulo State. The chairperson indicated that cassava production is mostly concentrated in the three provinces of Sao Paulo, Para and Mato Grosso (all 3 in the Southern Part of Brazil). The association tries to link producers of fresh roots with commercial processors and markets by advertising cassava on the market and identifying potential buyers locally and international. Trucks of fresh cassava from individual farmers who are members to the association come to the offices of the association to be weighed before the cassava is delivered to processors. The farmers pay a contribution of about $3 to the association secretariat for services.
Tempered Cassava flour

The Gabi Company is situated in the similar rural town as the cooperative. The company purchases cassava flour from a factory and takes it to the GABI factory in Candido Mota (10 km from Assis) where the blends are added to the native cassava flour.

Gabi produces cassava-blended flour (Farofa) for both the domestic and export markets. After the dry cassava flour is delivered to the factory, it is mixed with products such as garlic, onions, salt, red pepper, vegetable oil, meat soup, salt and glutamate monosulphate. The process has three stages. The first stage involves preparation of the materials to be used in the mixture. This includes washing, weighing and measuring of ingredients. The second stages involves the pre-treatment of the ingredients such as boiling cooking oil, making the premixes and the actual mixing with the cassava flour in mechanized rotating drums. The last stage involves packaging the final product in 1kg and 500g packets ready for the market.

Gabi produces about 14 tons of blended cassava flour per day mainly for the domestic market. Out of this, one container with 18 tons is exported per month to Cape Verde, other markets are USA and Japan. The average cost of unblended flour is $0.50/kg while the blended flour fetches a price of $1/kg. The equipment at the factory is meant for large-scale operations and has an estimated total investment of $800,000. The four packaging machines imported from Germany cost 400,000 USD.

Production of cassava leaves silage

A visit was made to Mr Antonio Yamamoto's farm where cassava leaves and stems are used as silage for feeding beef cattle. Mr Yamamoto was an electrical engineer in Sao Paolo City who gave up his profession to become a farmer. He now has 500 ha of land where he is keeping 500 animals, producing soybean and cassava. About 50 ha of his land is planted to cassava. The cassava roots are sold to Halotek-Fadel Starch Company near Assis. In the year 2001, the farm prepared over 600 MT of silage from cassava leaves and stems using the heap method. Most of the silage was already used to feed the beef cattle however a few heaps were remaining after 10 months of storage. The farm is highly mechanized (cassava planting, harvesting and chopping of the leaves is done using tractors.

The farm ran trials in the 2000/2001 season on animals to see the effect of feeding cassava products on the productivity of meat. The proximal analysis of the silage is summarized in table 1. Data was also recorded on the response of the animals to different feeds, which included a commercial standard feed as a check.

Visit to IAC substation in Assis

Teresa Lozada Valle a cassava breeder based at IAC headquarters in Campinas accompanied the team. A visit was made to the IAC substation based just outside Assis town. Dr. Ricardo A.D. Kanthack, the Director of the station, briefed the team about the main mandate and activities of the station and afterwards he showed various cassava breeding and evaluation trials on–station. The major activities included breeding sweet cassava varieties and selecting varieties for processing. One of the criteria for selecting new improved varieties was resistance to cassava bacterial blight and super elongation and ability of the clones to
withstand mechanical planting and harvesting. Other trials conducted included time of harvesting, and spacing trials. Spacing trials had populations ranging from 5000 to 20,000 plants per ha. First harvest was done 6 months after planting and at two months interval. One of the highlights for the research program is that it had identified four varieties two each for good and poor soils.

Visit to Cooperativa Agropecuaria de Ubirajara

This cooperative is owned by farmers living around several villages. The name of the cooperative is Cooperativa Agropecuaria de Ubirajara-Cauca. Two officials Mr Rua Antonio Luiz dos Santos and Mr Genezio Bocardi conducted the team around the factory. The processing plant produces two types of products both prepared out of cassava: tempered cassava flour (like Gabi) and frozen, pre-cooked cassava sticks. The process of producing blended flours involves mixing cassava flours with products such as soybean, onions, spices, garlic and oil (just like Gabi although the packaging is done with less sophisticated equipment). The plant had been producing cassava–blended flours since 1996 and has the capacity of 2 tons per day.

The other part of the plant produces frozen, pre-cooked cassava sticks for the domestic markets. The process involves mechanised removal of the outer peel with a wooden washer, peeling of the remaining peel, chipping into different sizes using knives and cutters both operated by hand, grading, boiling in water and steam, cooling, packaging and freezing ready for the market. Twenty people are involved in the peeling and each peels 83 kg per hour. Chipping is also done manually and each person chips 125 kg/hour. The economic threshold is 130 kg per person per day for the factory to make profits. One bag of 12.5 kg is sold at 74 Real (2.47 USD/kg) while the production cost is around 50 Real/12.5 kg (which equals 1.67 USD/kg). The final product is packaged in plastic bags each weighing 125 kgs. The main buyers for the product are in Sao Paulo. Pratigel (a big Supermarket chain in Brazil), which is the biggest client of the cooperative, provides packaging material, freezing equipment and transport.

Visit to the University of Campinas

During the last day of the tour the team visited the University of Campinas and met Dr. Y.K. Chang. Prof. Chang is the head of the Food Engineering Department, Departamento de Tecnologia de Alimentos. He introduced the team to a number of his staff involved in cassava post-harvest research. Dr. Chang showed different food labs and equipment including a steam operated double screw extruder. This model is used for developing all kind of new products out of cereals. Most of the product development is carried out in close cooperation with the private sector and companies often pay for using the extruder. The research team showed us different extrusion snacks (rice, cassava, etc.) as well as a flat shaped biodegradable sheet, usable for packaging material.

Different research activities related to cassava were discussed. One female researcher mentioned the work in Northern Brazil (Amazonia) on the development of a blend out of a nut similar to the cashew nut and cassava. The local nut is normally cold pressed and after extraction of the oil the cake can now be used in the blend as it has a high protein level (45–50%). The pulp has a complete amino acid range.
This was a short visit to the Food and Nutrition Centre in Campinas which is a sister institute of IAC. The team met the head of the department (Dr. Shirley Aparecida García Berbari). She recently completed her PhD thesis on producing croquettes of cassava using processed flour as a starting point. Dr. Renatta K. Grizotto conducted her PhD thesis on the use of cassava in fried chips.

Main observations and some conclusions

A. Cassava production and utilisation is clearly much better developed in the areas the team visited than any place in Sub Saharan Africa (except the starch factory in South Africa). The commercial production systems are all driven by, and linked with, various local and international markets. Recently the Brazilian government has put up new legalisation that requires the use of cassava flour in bakery products between 10–15% depending on the product. This new law will further boost the production and marketing of the crop in Brazil.

B. Average yields of cassava can be estimated between 25–35 MT of fresh roots/ha. Sao Paulo State is one of the leading agricultural production areas in Latin America with multi crops/year, relying to a large extent in mechanisation and inputs like fertilisers and chemicals to control disease and pests. Major drive for this high capital production system is the higher labour wages (average wages are 8–10 USD/day) and increasing market demand. Please notice that just the most developed parts of Colombia and Brazil were visited during this trip, we do realise that the situation might differ very much in other parts of Latin America.

C. We observed very interesting and fruitful public–private partnerships (PPP) between researchers (both from CIAT/CLAYUCA and national staff of local research institutes) and a wide range of private sector partners. The CLAYUCA team has developed an impressive network with various private sector people and researchers and is in a good position to act as some sort of clearing house between the research/public sector and the private sector. The team has experts of different disciplines, works with graduates and students of Universities and is getting funds from private and public sector partners to conduct specific research to get practical and commercial interesting/applicable research outputs.

D. This network is providing more focussed research agendas not only for CIAT research projects but also for its partners in the public sector. More focussed research activities, providing tangible outputs, will also lead to higher chances of funding.

E. We noticed that most private sector partners are willing to pay themselves for research as long as the research satisfies their information and technology demands. Unfortunately, up to now this is not the case in Africa, as we need to identify the real champions among the industries to develop successful products, technologies and markets.

F. This study tour has been very interesting for SARRNET staff as it provides us with a set of new ideas and concrete technologies which will serve as guidance for future research.
and development activities i.e. to develop more partnerships with private sector stakeholders to commercialise cassava production.

6.4. List of people met and institutions visited

6.4.1. CIAT–Cali

**CIAT Senior Management team:**
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7.0. Trip to Tanzania (Africa) to Provide Technical Support to SARRNET and the New Tanzania Animal Feed Information Centre

Consultancy Trip Report
October 27–November 10, 2001

Julián Buitrago A.

7.1. Objectives

- To participate in meetings and discussions related to the objectives and future SARRNET activities mainly related to the Tanzania Animal Feed Information Centre (TAFIC)
- To provide training and technical support to the TAFIC Coordinator (Dev–Anand Jani)
- To prepare demonstration feeding programs based on cassava root and leaves for broilers, layers and dairy cattle.
- To present information to feed manufacturers and animal producers on the possibilities for cassava usage in animal feeding.

7.2. Itinerary

October 27: Cali–Caracas–Amsterdam
October 28: Amsterdam
October 29: Amsterdam–Dar es Salaam
October 29–November 9: Dar es Salaam
November 9: Dar es Salaam–Amsterdam–Caracas–Cali

7.3. Summary

Since the new Tafic Business Center is being organized, most of the time was dedicated to provide information to Mr. Dev–Anand Jeni, who is going to coordinate the animal feed activities in the Centre. The basal nutritional information on local feed resources was prepared and stored in the computer as a very important step for all future feeding programs. A basal matrix was prepared which will permit the calculation of most diets for broilers, layers and dairy cattle. Nutritional parameters were also prepared in order to provide balanced programs under local conditions. Nutritional information on local cassava roots and leaves was included as important feed resources for future use in poultry, swine and dairy feeding.

Part of the time was also oriented to train the Tafic Coordinator (Dev–Anan Jani) in the use of the new feed formulation software (FeedLive). The importance of gathering accurate information on feed ingredients and nutritional values was emphasized since technical support through computerized feed formulation will be one of the main activities of Tafic.
Two important meetings with local feed processors were organized in order to analyse the possibility of establishing the Animal Feed Information Centre. There was complete agreement about the importance of this initiative. A preliminary committee was confirmed during the second meeting in order to prepare the constitution and a formal proposal for activities to be developed in the near future.

Visits to the Ministry of Animal and Water Resources in Dar es Salaam, the Sokoine University of Agriculture in Morororo and the Ilonga Agricultural Research Institute in Kilosa were also completed as part of possible joint projects with cassava and soybean utilization in animal feeds.

Together with Messrs. Dev-Annand Jani and Salim Msellem the preparation of the feeding trials in broilers and layers was discussed in order to demonstrate the possibility of including cassava roots and leaves in commercial diets.

7.4. Detailed report

October 29:

Arrived in Dar es Salaam together with Mr. Bernardo Ospina (CLAYUCA). Lodging at the Courtyard hotel in Dar es Salaam.

October 30:

A.M: First meeting with Messrs. Sicco Kolijn (IITA-Sarrnet), Nzola Mahungu (IITA-SARRNET) and Bernardo Ospina (CLAYUCA) in order to review basic information on the present SARRNET activities and discuss the main technical points to be considered during the present visit. A general review of the previous visit to Tanzania during February 2001 was included with special emphasis to the market survey with poultry producers.

Preliminary information on the new initiative to establish a Business Centre to provide technical support to the animal feed industry was received, since this was one of the main activities to be considered during the present visit. The initial objectives were analysed as a first step to enrich the support activities to local animal feed processors.

P.M: Together with Mr. Dev-Annand Jani, Tafic Coordinator, a first revision of the local feed ingredients was accomplished. The additional information needed was obtained from different sources including overseas information in order to develop reliable tables for future use. Since this information will be changing, special codes will be used in all future references. Technical information for future additions and modifications will be facilitated through the coding system.

October 31:

A. M: Discussion and preparation of the Agenda for the meeting to be held on Saturday (Nov 2) with the potential stakeholders of the Tafic Business Center. A group of 20–30 persons are being invited to join Tafic and participate in the support activities to the animal feeding sector. Invitations are open to members of TAFMA (Tanzania Animal Feed Manufacturers Association) and to the private, government, university and independent sectors.
Visit to the Ministry of Livestock and Agriculture. Meetings with Messrs. Mathew J. Munissi (Agricultural Sector Project), Dr. Boki (General Livestock Director) and Mr. J. Mwambo (Deputy Director Livestock).

Up to date information on the animal feed sector in Tanzania was obtained. Around 400,000 tons of finished feeds per year are being produced by the industrial sector plus more than 100,000 tons produced by non-commercial producers at the farm level. More than 90 per cent of the total production is used for the poultry industry, mainly broilers. The quality problems of feeds are limiting the productivity in all species. Broilers take almost two months to reach a total weight of 1000–1200 grams. Most feed ingredients are produced locally, mainly corn, cottonseed cake, maize by-products, rice by-products, wheat by-products, sesame meal, coconut cake, blood meal and local fish meal (sardine and tilapia). Most of the hominy feed and soybeans are imported.

Sanitary problems in some feedstuffs are limiting their use, mainly salmonella in fish meal and potential transmissible infections in blood meal. Since high-density energy and protein sources are not available, the interest in soybean production was emphasized. Technical and institutional support from the government was offered for future developments. The interest in new techniques for mechanized management and drying of cassava was also discussed with important support from the Agricultural Project Sector (Mr. Munissi).

Visit the Balton Tanzania Ltd. for a revision of second-hand laboratory equipment as a possibility to be acquired by the Tafic Business Centre for laboratory analysis of local feed ingredients. Mr. Eliezer Frumerman, General Manager, will be willing to receive a purchase proposal since this equipment is not being used. Apparently most of the equipment and materials are in good conditions and very little additional equipment will be needed for the normal proximal analysis (protein, ash, dry matter, ether extract and fibre). The proximal analysis of feed ingredients and finished feeds may become a very important support service provided by Tafic to local feed processors.

November 1:

Meetings at the SARRNET office to continue assembling of information and completing the first table of local ingredients. The program for the meeting with Tafic was also reviewed.

Several formulations were calculated using the new computer software in order to practice different alternatives for local poultry feeding programs.

Together with Messrs. Sicco, Mahungu and Ospina a visit to the Interchick cassava trials was accomplished. Although there is no information on yields yet, the positive effect of poultry manure fertilization was clearly observed in the field trials. New trials will be initiated with both cassava and sweet potatoes in order to obtain reliable information for future developments in animal feeding projects.

November 2:

The main activities were related to the preparation of feeding projects based on the use of cassava roots and leaves for local trials. Broiler and layers will be included in the demonstration trials. Most demonstration trials will be conducted at the Nguva Farm in Dar es Salaam where good facilities are available. Mr Salim Msellem, owner of the farm, will be closely cooperating
with Tafic during the fieldwork. Dev-Annand Jani will supervise the trials and will collect the field information in order to prepare a final report once the trials are finished. If all experimental materials can be obtained on time, the broiler and layer trials can be conducted simultaneously and obtain results in 30–45 days. A copy of the summarized projects is included in Appendix.

Mr. Salim Msellem is also trying to initiate a commercial cassava production agreement with local farmers where he will provide agronomic support to the farmers and will purchase the roots and leaves for animal feeding.

November 3:
Participation in the meeting at the SARRNET conference room with the potential members of Tafic. Around twenty people attended the meeting where complete information about the importance of Tafic was provided. The program of the meeting included a general presentation of feed and animal production in Latin America (J. Buitrago), information about CLAYUCA as an important support for SARRNET activities (B. Ospina) and an open discussion about the proposal for a NGO (Tafic) to provide technical support to local feed manufacturers. Important participation from several feed manufacturers was obtained. All participants expressed a lot of interest and there was special commitment from most of them in the formation of the Business Centre.

November 5:
Meeting with Dev-Anand Jani in order to review the ingredient analysis table prepared by the Sokoine University of Agriculture, through the Foodnet–SARRNET Project. Mrs. Germana Laswaig has been collecting the information and the preliminary results were sent for revision. Some local products have been analysed but there is a lot of information that has not been obtained yet. However the project will include most of the local products with potential to be used as animal feed ingredients. The final information will provide a good background for a more reliable feed formulation program although there is a need to continue with this activity as new products and new processing techniques keep changing the nutritional composition of feed ingredients. Through the review of the first analysis results a wide variation in some products was observed, mainly in fiber, protein and ether extract. The variability is larger for by-products like cottonseed cake, sunflower meal, maize bran and rice polishing, due to the variation in processing techniques and adulteration problems. This extreme variation makes it very difficult to formulate animal feeds that will provide a constant good performance, especially when a high proportion of the diet is based on these products. A more frequent follow-up is needed for this type of products. Other products like maize, sorghum, cassava chips, cassava leaves, soybeans will be much easier to handle, since variations are very small and adulteration is more difficult as whole products. Once they become milled (corn meal, cassava meal) adulteration becomes a problem.

The information obtained so far from the SUA Project plus the local tables already reviewed were used as the basic data to be considered as the first Tafic Feed Composition Tables for immediate use. Based on this information, the first feeding trials for broilers and layers will be conducted.

A visit with Mrs. Gren Moshi from Twinga Feeds Ltd. was attended in order to explain them about the use of cassava roots and cassava leaves in broiler diets. The owners are considering
buying a pelletizing machine and improving production of commercial feeds. A new meeting was proposed for next Thursday.

During the afternoon, a new meeting with Mr. Salim Msellem was accomplished in order to exchange information in relation to two feeding trials to be conducted at his farm to evaluate broiler and layer diets with increasing levels of cassava leaves and cassava roots. Feeding trials will be initiated during the present month as an activity coordinated by Tafic.

November 6:

Trip to Morocoro–Kibaja–Kilosa together with Mr. Dev Adnan Jani. Leave Dar es Salaam at 7:30 a.m. Arrived in Kibaja at 10:00 for a first visit to Intermech Engineering Ltd. to talk with Mr. Peter Chisawillo about the equipment for processing of cassava. Mr. Chisawillo has been participating in the development of cassava chippers for farm use. He is willing to participate in other developments specially related with cassava drying. There is the possibility of having some future developments based on technology which has been proven in Colombia and with possible applications in Tanzania. According to Mr. Chisawillo, conventional energy sources in Tanzania are very expensive. He considers that the mixed sun–artificial drying will be possible with a combination of used oil and water or with biogas. Based on this visit, the Colombian engineers will be contacted and asked about the possibility to elaborate on this project with Mr. Chisawillo cooperation.

The second visit to the Ilonga Agricultural Institute in Kilosa was mainly related to the exchange of information in relation to the soybean projects being conducted in the region. Both the Zonal Director, Dr. A. J. Moshi, and the Zonal Research Coordinator, Dr. F. A. Myaka, were very cooperative and provided complete information on the type of work they are involved at the present time. A very important development is being conducted with the introduction of new soya varieties in the region, mainly for human nutrition but also for animal nutrition, once the market is developed. According to the information obtained, there is a lot of potential for soybean cropping since yields could reach 2 tons per hectare and farmers will be willing to produce soybeans in single or mixed crops. There are good soils and sufficient rains in most parts of the region. As a complement, there is a program coordinated by the Ilonga Agricultural Institute related to the promotion of soybeans in human consumption. Dr. Myaka has been working in local food preparations based on soybeans and there is a lot of interest to continue not only with this type of projects but also to initiate new projects in animal nutrition where soybeans and cassava provide the largest part of the diet.

The Research Institute offers an interesting possibility for SARRNET in the developing of combined agronomic projects where cassava and soybeans may be involved. The technical capacity observed, the interest demonstrated by the research technicians, and the infrastructure and facilities for the conduction of trials, provide a solid support for local agronomic studies and demonstration trials with cassava and soybeans as well as the possibility of soybeans for human food projects. A closer relationship of SARRNET with the Research Institute is recommended.
November 7:

The Sokoine University of Agriculture in Morogoro was visited during the morning. Drs. Abiliza Kimambo, Faustin Lekule and Germana Laswai were interviewed during the visit in order to exchange information about present and future developments in the Animal Science Department in relation to poultry and swine feeding projects. Drs. Lejule and Laswai are already involved with SARRNET projects, which will provide important support to the local feed processors. These joint activities will guarantee a larger involvement with commercial production since the University has not participated to the needed extent.

A very important support may be obtained from the University in relation to laboratory facilities to prepare more reliable information on quality of local feed ingredients. Some information has been obtained but still there is a lot of variability in some of the results reported. Some of the inconsistencies were reviewed with Dr. Laswai who is working in a joint project with SARRNET. Since the basic information on nutrient composition is the most urgent need for the Business Center (Tafic), the exchange of information between Tafic and SUA is one of the main objectives at the present time. Dev–Anand Jani is well aware of this activity and will be preparing very complete and reliable feed composition tables based on the updated information obtained during the present visit and the future laboratory results from SUA.

Returned to Dar es Salaam during the afternoon.

November 8:

Most of the morning was spent at the SARRNET office reviewing some of the information handed-in by the feed processors related to the role of Tafic in providing some important services to the feed processors. According to this information, all processors who participated in the previous meeting are willing to pay for the services to be provided and consider the feed formulation support as a very important technical support. Information on feed ingredient composition and marketing was also considered to be key activities for Tafic.

A meeting with Mr. Charles Mtoi from the Tanzania Agricultural Research Programme was also accomplished during the morning. Mr. Mtoi is working part-time with TARP II in Tanzania and East Africa. Some of the cassava activities are complementary to SARRNET and there is the possibility to combine some efforts in the animal feeding projects based on cassava. Mr. Mtoi will be in contact with Dev in future opportunities to complement the information.

The meeting with the first Tafic committee was accomplished during the afternoon. Besides the members previously selected, Mr. G. Moshi from Twiga Feeds Ltd. was invited considering his experience in this type of activities. Very positive results were obtained during the meeting and all participants provided total support to the proposal to establish the Business Centre. There is a general consensus about the importance of Tafic as a Center for technical information and marketing support to the animal feed processors and independent animal producers. Two committees were named in order to prepare the constitution and bylaws as well as the technical activities to be considered by the Centre. The next meeting was proposed two weeks later when the first draft of the constitution will be revised and a formal Board of Trustees will be elected. Several proposals were analysed in relation to the type of organism (Association, ONG, etc), the mechanism for selection of members and the activities to be developed by the Center. An
effective cooperation will be received from SARRNET, Tafma and the Ministry of Livestock during the formation of the Centre. Details of the meeting will be included in the minutes to be prepared by Dev, as Coordinator of Tafic.

November 9:

The main activities during the last day of the visit were related to the revision of the nutritional software and additional training to Dev in the calculation of diets and feeding trials.

Mr. Salim Msellem also participated in the different meetings since his interest is oriented to cooperate with Sarmet–Tafic in several activities related to the animal production projects. The demonstration trials with cassava roots and leaves for broilers and layers will be conducted with his cooperation. Several details for the conduction of the trials and the preparation of experimental feeds were discussed. Final protocols of the trials were prepared considering the modifications approved during the last revision.

Return trip Tanzania–Colombia.

Julián Buitrago A.

November 12, 2001.
8.0. Trip to Tanzania and Malawi to Provide Technical Support to the SARRNET/Tafic Animal Nutrition Projects

Consultancy Report
May 3–May 17, 2001

Julián Buitrago A.

8.1. Objectives

- To review activities and feeding projects proposed in earlier visits.
- To participate in meetings and discussions related to the objectives and future SARRNET activities in Tanzania and Malawi especially related to the Tanzania Animal Feed Information Centre (TAFIC).
- To provide training and technical support to the TAFIC Coordinator (Dev–Anand Jani).
- To prepare demonstration feeding-programs based on cassava root and leaves for broilers, layers and dairy cattle both in Tanzania and Malawi.

8.2. Itinerary

May 03: Cali–Miami (Avianca 02)
May 03: Miami–Amsterdam (KLM 6058)
May 04: Amsterdam–Dar es Salaam (KLM 571)
May 04–May 10: Dar es Salaam–Blantyre–Lilongwe (Air Malawi 6201)
May 10: Lilongwe
May 10–16: Lilongwe–Nairobi–Amsterdam (KLM)
May 17: Amsterdam–Caracas–Cali

8.3. Detailed report

May 03–May 05:

Trip Cali–Miami–Amsterdam–Dar es Salaam

May 06:

Meet with Sicco Kolijn, Rodomiro Ortiz and Bernardo Ospina (SARRNET, IITA and CIAT) for visits to different cassava demonstrations trials around Dar es Salaam and Kibaha. Three important visits were accomplished:

Tan Dairy farm owned by Mrs. Anne Mmari where a cassava leaf crop is being evaluated as a feeding alternative for dairy cows. Mrs. Mmari owns a milk processing plant where several milk producers bring fresh milk for further processing. There is a two hectare trial with improved
cassava varieties provided by SARRNET as the basis for a feeding program for dairy cows based on fresh and ensiled cassava leaves.

Odetwa farm owned by Mr. John de Wolff, which is also a dairy farm with, confined dairy cows where pasture hay is being used as the main feed resource. There is one-hectare trial where cassava leaves will be processed in order to obtain hay to be mixed with other ingredients.

Sugar cane research institute in Kibaha: There is a complete research program sponsored by SARRNET for agronomical studies with cassava and sweet potatoes. As part of a more general research program on crop management, the effect of cow manure and broiler litter as fertilizers to improve leaf production is being evaluated.

Once these experimental trials with cassava leaves and roots finish there will be a very important scheme for cassava leaf and root production as key ingredients to be included in animal feeds for cattle, poultry and swine production. Based on the present agronomic results several feeding trials will also be conducted in order to have practical proposals for ruminant and non-ruminant feeding linked to the cassava crop. This type of information is still in its initial stage since there is little knowledge on intensive cassava forage production and intensive forage/root production for commercial feeding. The information obtained will be of wide application in several regions where cassava may become the best alternative for energy and protein production for small and large-scale animal feeding projects.

May 07:

Tafic organized a brainstorming meeting at the SARRNET office where Tafic stakeholders, farmers and extension agents were invited in order to discuss and propose ideas about the mobilization of technical information to the livestock sector in Tanzania.

There was a poor attendance to the meeting and the information obtained did not provide a clear indication for the future activities of Tafic. There has been little commitment of the initial stakeholders, which have had limited Tafic activities with the feed processing sector. Some recent contacts with poultry and dairy producers have indicated that Tafic efforts may be reoriented. Special emphasis should be oriented to a more direct contact with field activities and animal producers. A stronger participation in farm demonstrations and information exchange with cassava producers as well as poultry and dairy farmers will provide a more solid mechanism for the future Tafic activities.

A meeting with Mr. Timothy Nyanamba was also organized in order to provide technical support to a new project in Kenya to analyse the potential of the quality protein maize (qpm) recently introduced from CIMMYT (MEXICO). This grain has been developed for animal feeding purposes considering its higher concentration in the essential amino acids lysine and tryptophane. Considering the improved amino acid profile, the main applications will be for swine and poultry feeding. The price differential with normal corn cannot be very large since synthetic amino acids have provided an efficient supplementation to normal corn at a low price. A feeding program for broilers and pigs was calculated as a first step for the local evaluation of qpm in Kenya. The possibility to conduct an additional feeding trial in Tanzania where cassava root meal is also included will be considered. Once these feeding trials are finished and analysed, the feasibility of this type of corn may be evaluated as an alternative to normal corn or as a
complement to cassava root meal. The different diets for these evaluations were calculated and will be discussed in order to decide when and where they will be conducted (See section 9.1.)

May 08:

Meeting with Mr. Salem Msellem to analyse the possibility to conduct several feeding trials as a joint effort with Tafic. As it has been previously discussed, Tafic has a very important opportunity to develop a complete scheme for animal feeding programs based on cassava leaves and roots which will be of interest to commercial producers. After visiting Mr. Msellem facilities and discuss with him the different alternatives, a clear proposal was obtained: there is a total commitment from Mr. Msellem to cooperate with Tafic in the evaluation of the feeding projects for dairy, broilers and layers. Permanent technical support from Tafic has to be provided as well as periodic supervision of the field works.

The participation of other commercial dairy and broiler producers was also considered as a very important tool to obtain reliable and practical information to be disseminated by Tafic. Mrs. Anne Mmari (Tan Dairy farm) and Mr. John de Wolff (Odetwa farm) have been participating in the agronomical studies and it will be interesting to include the animal feeding trials to complement the information already obtained. Their cooperation will also largely depend from the day-to-day support from Tafic. Considering the present situation, five feeding trials have been proposed to be initiated during the coming six month period:

Table 14. Feeding trials to be implemented in Tanzania

<table>
<thead>
<tr>
<th>Animal operation</th>
<th>Feeding scheme</th>
<th>Location</th>
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<tr>
<td>Milking cows under a mixed grazing–confined system</td>
<td>Cassava silage: 80 % leaves + 15 % fresh roots + 5 % molasses, mineral salt.</td>
<td>Mr. Salim Msellem farm</td>
</tr>
<tr>
<td>Milking cows under a completely confined system</td>
<td>Cassava silage: 80 % leaves + 15 % fresh roots + 5 % molasses, mineral salt.</td>
<td>Mrs. Mmari dairy farm</td>
</tr>
<tr>
<td>Milking cows under a completely confined system</td>
<td>Dry feeding: cassava leaf hay + 15 % cassava root flour + 5 % molasses, mineral salt.</td>
<td>Mr. John de Wolff farm</td>
</tr>
<tr>
<td>Broilers</td>
<td>Cassava root meal + cassava leaf meal</td>
<td>Mr. Salim Msellem farm</td>
</tr>
<tr>
<td>Layers</td>
<td>Cassava root meal + cassava leaf meal</td>
<td>Mr. Salim Msellem farm</td>
</tr>
</tbody>
</table>

May 09:

Based on the meetings and previous visits, protocols for the above feeding trials were prepared and discussed with Mr Dev–Anand Jani (Tafic), Sicco Kolijn (Sarmet) and Bernardo Ospina (CLAYUCA). (See sections 9.2. to 9.6.).

In addition, performance controls to be recorded were discussed with dev. a chronogram to be followed during the next six months was also considered in order to obtain final results by september, 2002. The final results will be the basic information to be used in the preparation of
feeding manuals for commercial production of dairy and poultry as well as the recommended practices for leaf and root cassava utilization as hay, flour, and silage.

8.4. Conclusions and Recommendations Based on the Visit to Tanzania

During the earlier visit to Tanzania in October, 2001, the conduction of three feeding trials based on cassava roots and cassava leaves for broilers, layers and dairy cattle was proposed as a first step to obtain local information on commercial possibilities for animal feeds based on cassava. Diets were calculated using local feed ingredients to supplement cassava root and leaf meal. Mr. Salim Msellem offered the needed cooperation at his farm where animals and facilities are available.

Unfortunately it has not been possible to carry-on the feeding trials and local results have not been obtained. Little support has been obtained from feed processors. On the other hand, important progress has been obtained in the production techniques of cassava roots and leaves through local demonstration trials. An important amount of leaves and roots are available for the conduction of feeding trials.

Demonstration trials with high yielding cassava varieties have shown an important potential for leaves and roots as strategic resources of energy and protein for ruminant and non-ruminant feeds. The use of cattle manure and poultry litter as organic fertilizers have also contributed to obtain a significant increase in the yield of leaves. Based on preliminary results, root yields of 30 tons/ha. May be obtained at a commercial basis. Intensive leaf production with cuts every 3–4 months can provide close to 100 tons of fresh material per year.

New feed demonstration trials were proposed for implementation during the following 4–5 months. Local production of cassava leaves and roots and the support from local producers (Mrs Mmari, Msellem and de Wolff) will facilitate the feeding projects. Five feeding trials will be conducted with the cooperation of the three producers already mentioned and under the supervision of Dev-Anand Jani (Tafic).

The chronogram for data collection and supervision of the main trial activities was prepared in order to facilitate the overall analyses at the end of the demonstrations. Periodical reports can also be obtained and analysed following the parameters proposed (See section 9.6.)

May 10:

Trip Dar es Salaam–Blantyre–Lilongwe.

Arrive in Lilongwe at 1 p.m. and meet Mr. Vito Sandifolo for a visit to the SARRNETt office and the cassava production trials at the agricultural research station in Lilongwe. The cassava trials have confirmed the large potential for the production of cassava leaves as a source of protein for animal feeding. Different planting distances and harvesting methods are being compared in order to obtain a recommended model for intensive leaf production. The results will provide an important support to several small and large-scale producers in the region.

May 11:
A group of small farmers (Kandiyani / Chitedze) was visited during the morning. This group has been participating in a joint project supported by SARRNET, the central region milk producers association and Land O’ Lakes. Cassava will be the basic feed resource for dairy cows on a totally confined system.

The Chitipi farm was visited during the afternoon. 55 hectares have been planted with improved commercial cassava varieties. Very positive results in yields and profits are foreseen according to the farm owner. The projected yields of 30 tons / ha. And the excellent performance of the improved varieties, have positioned the crop as a better alternative to the traditional crops. So far, the main limitation of the crop has been its susceptibility to termite attack. Information on biological pest control will be investigated with CIAT entomologists.

May 12:
Office work at the agricultural research station in Lilongwe

May 13:
Meeting with Land O’ Lakes representatives (Messrs. Collings Chimayula–regional coordinator–and Austin Ngwira–country coordinator) and dairy cattle producers (Mr. Clive Wilton and S. Themulca from Crempa)

The SARRNET team and Land O’ Lakes officers met during the morning in order to analyse the joint projects that could be conducted on dairy feeding in the region. Land O’ Lakes is implementing a dairy development program with the goal of increasing the production and productivity of milk with local feed resources as an alternative to maize and maize bran. The support from small farmers and the central region milk producers association (Crempra) has been obtained for the initiation of a strong effort to increase the number of cows and the production of milk for local consumption considering the very low per-capita consumption at the present time.

There is very little good quality grazing available for dairy cattle and most farmers depend on maize and maize bran. In times of food crisis maize becomes scarce and expensive leading to a deficit in animal feeds since people largely consume it.

Based on the recent results obtained through the SARRNET–CLAYUCA cassava agronomic trials, there is an important potential to include cassava leaves and roots as the main feed resources for the new strategy to improve dairy feed quality and quantity.

Yields of leaves in intensive leaf production systems can reach 100 tons per ha/year. Root production with improved varieties can reach 25–30 tons per ha/year. These high yields provide an important volume of protein and energy that can be directly used in cattle feeding.

As a first step of a joint SARRNET–Land O’ Lakes project, some feed demonstration trials will be conducted considering the inclusion of cassava leaves and roots as the main ingredient. The new technology will include on-farm demonstrations of high quality silage based on leaves, roots and molasses. A special mineral supplement will also be included.

A detailed protocol for this first stage has been prepared and is enclosed in Annex. Demonstrations on silage preparation and feed balancing for lactating cows will be performed at
the agricultural research station with cooperation from Messrs. Nzola–Meso Mahungu, Vito Sandifolo and France Gondwe (SARRNET). The following step will include demonstrations at the small farm level following the same techniques observed at the agricultural research station.

May 14:

Meetings during the morning at the Land O’ Lakes office in order to discuss the feeding trials proposal and define responsibilities for the field work. Ingredients and materials to be used in the demonstration trial at the agricultural research station were also collected and transported to the agricultural research station.

A visit to a soybean processing plant was made during the afternoon. There is a small insta–pro extruder available which will be suitable for soybean processing to be used in animal feeds. The capacity of the extruder is approximately 800–1,000 kg of soybeans per hour. It will be very interesting to find out the possibility to process soybeans and initiate demonstration trials with cassava–soybean diets for calves, poultry and pigs. Protocols for feeding trials can be prepared as a next step.

May 15:

A group of 15 farmers and technicians from Land O’ Lakes and SARRNET participated in the conference and field day at the agricultural research station in order to train farmers on the use of cassava and sweet potato as basic ingredients in dairy feeding programs and to demonstrate the methods for preparation of cassava silage and cassava meal diets, according to the following program:

Conferences:
- Introduction: NM Mahungu, France Gondwe (Sarrnet) and Austin Ngwira (Land O’ Lakes)
- Short training on feeding programs for dairy animals at the small farm level. J. Buitrago.
- Short training on cassava and sweet potatoes by–products as feed resources for dairy animals. J. Buitrago.
- Short training on silage techniques and dry feed mixing at the small farm level. J. Buitrago.

8.5. Demonstrations

- Field demonstration on silage preparation: cassava leaves + roots and cassava leaves + sweet potato tubers. J. Buitrago / F. Gondwe.

Conclusions and recommendations on the visit to Malawi

The impressive results obtained through the SARRNET demonstrations for cassava leaf production are stimulating small and large scale dairy producers to consider cassava leaf as a primary feed resource for the future expansion of dairy in the region.

Low production costs and high yields of improved varieties have shown the possibility for a new local agribusiness development of cassava roots for food and feed use. The experience already obtained at the Chitupiti farm will probably be followed by other small and large producers as a promising alternative to improve agricultural profits.
The conference and field day activities encouraged participating farmers and technicians to consider the new technology as a very viable tool to be implemented at the farm level. The possibility to start several demonstrations was considered as a very important objective in the near future. Most participants were very positive and are willing to initiate on-farm trials as soon as possible. Land O’ Lakes and Sarrenet will provide an effective support to these activities since there is an interesting demand from farmers.

The animal production activities could be primarily based on the use of leaves and roots for dairy production but poultry and pig production could reinforce the cassava based model, considering the availability of soybeans as a supplementary high quality protein.

Since the production of soybeans is viable in Malawi, the feeding trials in poultry and swine should include extruded full fat soybeans as a very important feed supplement to cassava. The mixture cassava root meal, cassava leaf meal and full fat soybeans have demonstrated optimum results in other countries and could also become the best alternative for poultry and swine feeds in Malawi.

It is very important to conduct several feed demonstration trials under Sarrenet and local institutional support to obtain reliable information to be extended to commercial farmers and to provide training materials for technicians and producers. As a first step, the proposal for feeding trials already mentioned for Tanzania with some minor changes may be also followed in Malawi.

As an overall conclusion, the importance of a seminar and training program to present the new findings of cassava utilization as an animal feedstuff was discussed. This activity should be opened to several countries in Southern Africa once the final trial results are obtained (probably during the forth quarter, 2002). A tentative program is enclosed.

Table 15. Proposal for feeding trials in Malawi with Land O’ Lakes and Sarrenet support.

<table>
<thead>
<tr>
<th>Animal operation</th>
<th>Feeding scheme</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milking cows under a completely confined system</td>
<td>Cassava silage: 80 % leaves + 20 % fresh roots</td>
<td></td>
</tr>
<tr>
<td>0 grazing</td>
<td>Mineral mixture.</td>
<td></td>
</tr>
<tr>
<td>Milking cows under a mixed grazing-confined system</td>
<td>Cassava silage: 80 % leaves + 20 % fresh roots</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mineral mixture.</td>
<td></td>
</tr>
<tr>
<td>Milking cows under a completely confined system</td>
<td>Dry feeding: cassava leaf hay + 15 % dried cassava roots + 5 % molasses.</td>
<td></td>
</tr>
<tr>
<td>0 grazing</td>
<td>Mineral mixture.</td>
<td></td>
</tr>
<tr>
<td>Broilers</td>
<td>Cassava root meal + cassava leaf meal + extruded soybeans</td>
<td></td>
</tr>
<tr>
<td>Pigs</td>
<td>Cassava root meal + cassava leaf meal + extruded soybeans</td>
<td></td>
</tr>
</tbody>
</table>

May 16: Return trip Lilongwe–Amsterdam

May 17: Return trip Amsterdam–Caracas–Cali.

Julián Buitrago A.
May 22, 2001
9.0. Animal feeding experiments proposed

9.1. Feed demonstration trials based on quality protein maize (QPM) as an alternative to common maize

QPM has been recently introduced from CIMMYT (Mexico) to Kenya as a possibility to be used in animal feeding. Its higher concentration in lysine and tryptophane compared to normal corn could provide a competitive advantage over normal corn. A first comparison is proposed in the following diets for growing pigs and broilers, since lysine becomes a very important amino acid in these diets and this is the principal advantage in QPM. With the common feed ingredients, tryptophane is not normally a limiting amino acid.

<table>
<thead>
<tr>
<th>PIG STARTER</th>
<th>BROILER STARTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>QPM</td>
<td>Normal maize</td>
</tr>
<tr>
<td></td>
<td>Soybean meal</td>
</tr>
<tr>
<td></td>
<td>Cassava meal</td>
</tr>
<tr>
<td></td>
<td>Limestone</td>
</tr>
<tr>
<td></td>
<td>Bone meal</td>
</tr>
<tr>
<td></td>
<td>Lysine</td>
</tr>
<tr>
<td></td>
<td>Methionine</td>
</tr>
<tr>
<td></td>
<td>Salt</td>
</tr>
<tr>
<td></td>
<td>Vit–min premix</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>QPM</td>
<td>---</td>
</tr>
<tr>
<td>Normal maize</td>
<td>761.2</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>200.0</td>
</tr>
<tr>
<td>Cassava meal</td>
<td>---</td>
</tr>
<tr>
<td>Limestone</td>
<td>11.0</td>
</tr>
<tr>
<td>Bone meal</td>
<td>17.0</td>
</tr>
<tr>
<td>Lysine</td>
<td>4.91</td>
</tr>
<tr>
<td>Methionine</td>
<td>1.31</td>
</tr>
<tr>
<td>Salt</td>
<td>3.5</td>
</tr>
<tr>
<td>Vit–min premix</td>
<td>1.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MAIN NUTRIENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metabolizable energy, Mcal/kg</td>
</tr>
<tr>
<td>Protein, %</td>
</tr>
<tr>
<td>Lysine, %</td>
</tr>
<tr>
<td>Methionine, %</td>
</tr>
<tr>
<td>Metionine + cystine, %</td>
</tr>
<tr>
<td>Calcium, %</td>
</tr>
<tr>
<td>Av. Phosphorus, %</td>
</tr>
</tbody>
</table>
9.2. Demonstration trial with cassava roots and leaf meal for broiler diets

Planning: IITA-SARRNET-CLAYUCA-Tafic
Execution: Dev-Anand Jani
Salim Msellem
Location: Nguva Farm-Kigamboni
P.O. Box 22565
Dar es Salaam
10 m.s.n.m. 28–30 oC

9.2.1. Objectives

- To evaluate the effect of partially or totally replace corn by cassava root meal in commercial broiler diets.

- To evaluate the effect of including a low level of cassava leaf meal as a protein and pigment source for broilers.

9.2.2. Materials and Methods

Experimental animals

150 one-day old chicks will be included in order to compare three different diets. The first group of birds will be fed a commercial diet based on common ingredients. The other two groups will be fed diets based on different combinations of cassava roots and cassava leaves as a partial replacement of the conventional energy and protein sources.

Sanitary and management conditions will be the same in all groups. Ad libitum feed will be provided for all treatments.

Housing

The different groups will be housed in covered houses with a density of ten birds / m². Feeders and waterers will be available all the time for ad libitum consumption.

Experimental diets

Three experimental diets will be included in the present evaluation. The diets will be prepared at the farm facilities under the supervision of Tafí technicians and using local good quality commercial ingredients.

The control diet will be a normal broiler diet based on maize, maize bran, fish meal, blood meal, sunflower meal, cottonseed cake and the needed microingredients.

In the experimental diets, maize will be partially replaced by cassava root meal and cassava leaf meal, keeping the nutritional profile close to the control diet. Cassava leaf meal will be used as a protein and pigment source, whereas cassava root meal will be mainly used as an energy source.
All diets will provide 18.0 % and 17.0 % protein levels for starter and finisher and 2,900 kcal/kg as metabolizable energy for starter and finisher.

The detailed composition of the three starter and finisher diets is included in Table 1.

Experimental design

A total randomized design will be used, where each pen (replication) will be the experimental unit for feed consumption and feed conversion, whereas each bird will be the experimental unit for weight changes.

Experimental controls

Weight records at days 1, 21 and at the end of the experiment.
Daily feed consumption per pen
Total feed consumption per pen
Feed conversion (feed efficiency) per pen
% mortality per pen

Daily observations on litter conditions

Skin and internal fat pigmentation at the end of the trial
Sanitary conditions in each pen
Costs: Cost (per kilogram) of commercial and experimental diets.
Total production costs
Selling price of birds (per kilogram)
Starting date of trial:
Ending date of trial:
### Table 16. Composition of experimental diets for starter broilers

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>CONTROL</th>
<th>25% CRM</th>
<th>50% CRM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cassava root meal</td>
<td>250</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>Cassava leaf meal</td>
<td>60</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Maize</td>
<td>279</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Cottonseed cake (28)</td>
<td>120</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Fish (sardine) meal</td>
<td>107</td>
<td>157</td>
<td></td>
</tr>
<tr>
<td>Maize bran</td>
<td>120</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Sunflower cake</td>
<td>46</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Salt</td>
<td>3.5</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>Lysine</td>
<td>3.96</td>
<td>2.27</td>
<td></td>
</tr>
<tr>
<td>Methionine</td>
<td>2.82</td>
<td>2.96</td>
<td></td>
</tr>
<tr>
<td>Anticoccidial</td>
<td>0.50</td>
<td>0.50</td>
<td></td>
</tr>
<tr>
<td>Vit–min premix</td>
<td>2.50</td>
<td>2.50</td>
<td></td>
</tr>
<tr>
<td>Calcium carbonate</td>
<td>5.0</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Met. energy, kcal/kg</td>
<td>2,900</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protein, %</td>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lysine, %</td>
<td>1.22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methionine, %</td>
<td>0.58</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Met + Cyst, %</td>
<td>0.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium, %</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Av. P, %</td>
<td>0.45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. extract, %</td>
<td>4.8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 17. Composition of experimental diets for finisher broilers

<table>
<thead>
<tr>
<th></th>
<th>25 % CRM</th>
<th>50 % CRM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cassava root meal</td>
<td>--</td>
<td>250</td>
</tr>
<tr>
<td>Cassava leaf meal</td>
<td>--</td>
<td>60</td>
</tr>
<tr>
<td>Maize</td>
<td></td>
<td>300</td>
</tr>
<tr>
<td>Cottonseed cake (28)</td>
<td></td>
<td>120</td>
</tr>
<tr>
<td>Sesame meal (40)</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Fish (sardine) meal</td>
<td></td>
<td>91</td>
</tr>
<tr>
<td>Maize bran</td>
<td></td>
<td>120</td>
</tr>
<tr>
<td>Rice polishings</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Sunflower cake</td>
<td></td>
<td>40</td>
</tr>
<tr>
<td>Salt</td>
<td></td>
<td>3.5</td>
</tr>
<tr>
<td>Lysine</td>
<td></td>
<td>3.36</td>
</tr>
<tr>
<td>Methionine</td>
<td></td>
<td>2.64</td>
</tr>
<tr>
<td>Anticoccidial</td>
<td></td>
<td>0.50</td>
</tr>
<tr>
<td>Vit–min premix</td>
<td></td>
<td>2.00</td>
</tr>
<tr>
<td>Calcium carbonate</td>
<td></td>
<td>7</td>
</tr>
</tbody>
</table>

| Met. Energy, kcal/ kg | 2900 | Protein, % | 17 | Lysine, % | 1.10 | Methionine, % | 0.55 | Met + Cyst, % | 0.80 | Calcium, % | 1.00 | Av. P, % | 0.40 | E. extract, % | 4.5 |
9.3. Demonstration trial with cassava roots and leaf meal for layer diets

Planning: IITA–SARRET–CLAYUCA–Tafic

Execution: Dev–Anand Jani
Salim Msellel

Location: Nguva Farm–Kigamboni
P.O. Box 22565
Dar es Salaam
10 m.s.n.m. 28–30 oC

9.3.1. Objectives

- To evaluate the effect of replacing 50 and 100 percent of maize by cassava root meal in commercial layer diets.
- To evaluate the effect of including a low level of cassava leaf meal as a protein and pigment source for layers.

9.3.2. Materials and Methods

Experimental animals

150 layers will be used in order to compare three different diets. The first group of layers will be fed a commercial diet based on common ingredients. The other two groups will be fed diets based on two different combinations of cassava roots and cassava leaves as a partial or total replacement of maize in layer diets.

Fifty layers will be assigned to each treatment. There will be three treatments for a total of 150 layers.

Sanitary and management conditions will be the same in all groups. Ad libitum feed will be provided for all treatments.

Housing

The three groups will be housed in covered houses. Feeders and waterers will be available all the time for ad libitum consumption.

Experimental diets

Three experimental diets will be included in the present evaluation. The diets will be prepared at the farm facilities under the supervision of Tafi technicians and using local good quality commercial ingredients.

The control diet will be a normal broiler diet based on maize, maize bran, fish meal, sunflower meal, cottonseed cake and micro-ingredients.

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In the two experimental diets, maize will be partially and totally replaced by cassava root meal and cassava leaf meal, keeping the nutritional profile close to the control diet. Cassava leaf meal will be used as a protein and pigment source, whereas cassava root meal will be mainly used as an energy source.

All diets will provide similar protein (14.5 percent) and energy (2,700 kilocalories / kg) concentrations.

The detailed composition of the four diets is included in Table 1.

**Experimental design**

A total randomized design will be used, where each pen (replication) will be the experimental unit for feed consumption, egg production and feed conversion.

**Experimental controls**

Layer weight records at starting day and last day of the experiment.
Daily egg production per pen.
Daily feed consumption per pen.
Total feed consumption per pen.
Feed conversion (feed efficiency) per pen.
% mortality per pen.
Daily observations on litter conditions.
Weight and pigmentation of egg yolks twice a week: a sample of 5 eggs in each pen will be weighted and measured for yolk pigmentation using the Roche Fan.
Sanitary conditions in each pen.
Costs: Cost (per kilogram) of commercial and experimental diets.
Total production costs.
Selling price of eggs (per kilogram).
Starting date of trial.
Ending date of trial.
Table 18. Composition of experimental diets for layers

<table>
<thead>
<tr>
<th></th>
<th>CONTROL</th>
<th>50 % CRM</th>
<th>100 % CRM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cassava root meal</td>
<td></td>
<td>250</td>
<td>500</td>
</tr>
<tr>
<td>Cassava leaf meal</td>
<td></td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Maize</td>
<td></td>
<td>275</td>
<td>37</td>
</tr>
<tr>
<td>Cottonseed cake (28)</td>
<td></td>
<td>109</td>
<td>69</td>
</tr>
<tr>
<td>Fish (sardine) meal</td>
<td></td>
<td>97</td>
<td>131</td>
</tr>
<tr>
<td>Maize bran</td>
<td></td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>Salt</td>
<td></td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Calcium carbonate</td>
<td></td>
<td>80</td>
<td>74</td>
</tr>
<tr>
<td>Methionine</td>
<td></td>
<td>2.10</td>
<td>2.48</td>
</tr>
<tr>
<td>Vit-min premix</td>
<td></td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Met. energy, kcal/ kg</td>
<td></td>
<td>2.700</td>
<td></td>
</tr>
<tr>
<td>Protein, %</td>
<td></td>
<td>14.5</td>
<td></td>
</tr>
<tr>
<td>Lysine, %</td>
<td></td>
<td>0.80</td>
<td></td>
</tr>
<tr>
<td>Methionine, %</td>
<td></td>
<td>0.45</td>
<td></td>
</tr>
<tr>
<td>Met + Cyst, %</td>
<td></td>
<td>0.70</td>
<td></td>
</tr>
<tr>
<td>Calcium, %</td>
<td></td>
<td>3.75</td>
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<tr>
<td>Av. P, %</td>
<td></td>
<td>0.40</td>
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<tr>
<td>E. extract, %</td>
<td></td>
<td>3.4</td>
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</tr>
</tbody>
</table>
In the two experimental diets, maize will be partially and totally replaced by cassava root meal and cassava leaf meal, keeping the nutritional profile close to the control diet. Cassava leaf meal will be used as a protein and pigment source, whereas cassava root meal will be mainly used as an energy source.

All diets will provide similar protein (14.5 percent) and energy (2,700 kilocalories / kg) concentrations.

The detailed composition of the four diets is included in Table 1.

Experimental design

A total randomized design will be used, where each pen (replication) will be the experimental unit for feed consumption, egg production and feed conversion.

Experimental controls

Layer weight records at starting day and last day of the experiment.
Daily egg production per pen.
Daily feed consumption per pen.
Total feed consumption per pen.
Feed conversion (feed efficiency) per pen.
% mortality per pen.
Daily observations on litter conditions.
Weight and pigmentation of egg yolks twice a week: a sample of 5 eggs in each pen will be weighted and measured for yolk pigmentation using the Roche Fan.
Sanitary conditions in each pen.
Costs: Cost (per kilogram) of commercial and experimental diets.
Total production costs.
Selling price of eggs (per kilogram).
Starting date of trial.
Ending date of trial.
Table 18. Composition of experimental diets for layers

<table>
<thead>
<tr>
<th></th>
<th>CONTROL</th>
<th>50 % CRM</th>
<th>100 % CRM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cassava root meal</td>
<td>250</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>Cassava leaf meal</td>
<td>60</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Maize</td>
<td>275</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td>Cottonseed cake (28)</td>
<td>109</td>
<td>69</td>
<td></td>
</tr>
<tr>
<td>Fish (sardine) meal</td>
<td>97</td>
<td>131</td>
<td></td>
</tr>
<tr>
<td>Maize bran</td>
<td>120</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Salt</td>
<td>4.0</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>Calcium carbonate</td>
<td>80</td>
<td>74</td>
<td></td>
</tr>
<tr>
<td>Methionine</td>
<td>2.10</td>
<td>2.48</td>
<td></td>
</tr>
<tr>
<td>Vit-min premix</td>
<td>2.5</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>Met. energy, kcal/kg</td>
<td>2.700</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protein, %</td>
<td>14.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lysine, %</td>
<td>0.80</td>
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<td>Met + Cyst, %</td>
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<td>Calcium, %</td>
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<td>Av. P, %</td>
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<td>E. extract, %</td>
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9.4. Demonstration trial with ensiled cassava roots and leaves for diary feeding

Planning: ITA–SARRNET–CLAYUCA–Tafic
Execution: Dev–Anand Jani
Salim Msellem

Location: Nguva Farm–Kigamboni
P.O. Box 22565
Dar es Salaam
10 m.s.n.m. 28–30 °C

9.4.1. Objectives

• To evaluate a feeding program for diary cows totally based on cassava roots and leaves.

• To calculate the cropping area needs for both intensive cassava forage and intensive root production for a dairy operation based on cassava as the principal feed resource.

9.4.2. Materials and Methods

Cropping area and ensiling procedure

The final daily diet will be based on a leaves to roots ratio equivalent of 80 % fresh leaves and 20 % fresh roots. Taking into account the potential yields of separate cropping experiences with intensive leaf production (between 10–50 tons every three months) and intensive root production (20–30 tons every 12 months), the approximately cropping area for each material should be calculated.

Since the daily diet will be provided in an ad libitum basis of a silage mixture, the ensiled formulation should be prepared following the same proportion: 80 % leaves + 20 % roots.

After the cassava roots and leaves crops have been collected, the material has to be chipped, mixed, packed and ensiled in plastic bags. The bags should be sealed trying to eliminate as much air as possible from the ensiled material.

Ensiled bags will be stored for a minimum of three weeks in order to complete the silage process. After three weeks, the bags will be opened according to the daily feeding needs. The remaining bags can be opened every day until a new silage is prepared. Ensiled bags may remain for at least one year, if the ensiled mixture has been properly prepared and stored.

Experimental animals

Milking cows will be included in a feeding demonstration where most of the daily feed will be provided by the ensiled cassava leaf/root mixture. One control group under the standard feeding conditions should be included, if possible.

Sanitary and management conditions will be the same in all groups. Ad libitum feed will be provided for all treatments. Milking cows may remain on grazing conditions or semi–confined conditions.
**Experimental diets**

The cassava silage will be prepared at the farm facilities under the supervision of Tafic technicians.

The control group will be fed a normal commercial diet or the normal grazing program at the farm level.

The ensiled cassava leaf/root mixture will be provided every day to the experimental animals. Feed consumption will be based on farm variables, including the type of animals and the local productivity. For high yielding cows an approximate consumption based on 12 to 13 percent of the body weight should provide the needed nutrients for semi-confined animals (i.e. a 400 kg cow may consume between 45 to 52 kg of ensiled material).

If animals receive some grazing or green forage, less silage will be consumed and the adjustments should be introduced according to the farm management program.

All animals should receive a mineral–salt mixture and clean water as a complement to silage.

**Experiment controls**

Individual weight records of cows at starting day and last day of the experiment.  
Daily milk production per cow.  
Daily feed consumption per cow.  
Sanitary conditions of cows.  
Costs: Cost (per kilogram) of commercial and experimental diets.  
Total production costs

**Daily feeding program in total or semi-confined conditions**

The 80 % to 20 % leaves to roots ratio has been proposed as a balanced energy: protein mixture, which will provide most nutrients for lactating cows under confined or semi-confined conditions. If other feed resources (forages, molasses, pasture, urea, etc.) are included, the ratio and/or daily consumption should be changed.

The approximate amount of the ensiled mixture depend on several variables, but a total consumption based on 12 to 13 % of total body weight is recommended.  
i.e: A 400 lactating cow will need around 45–50 kg of the 2:1 ensiled cassava mixture.  
This mixture will provide around 1,400 grams of protein and 8.2 kg of TDN per day.  
*Ad libitum* mineralized salt should be provided or an approximate daily allowance of 120–150 grams per head.  
Starting date of trial.  
Ending date of trial.
9.5. Demonstration trial with cassava leaf hay and chipped and dried cassava roots for diary feeding

Planning: IITA–SARRNET–CLAYUCA–Tafic

Execution: Dev–Anand Jani
John de Dewolf

Location: Odetwa Farm
Dar es Salaam
10 m.s.n.m. 28–30 oC

9.5.1. Objectives

- To evaluate a feeding program for diary cows totally based on dried cassava roots and leaves (hay).

- To calculate the cropping area needs for both intensive cassava forage and intensive root production for a dairy operation based on cassava as the principal feed resource.

9.5.2. Materials and Methods

Cropping area and drying procedure

The final daily diet will be based on a leaves to roots ratio equivalent of 80 % dried leaves, 15 % chipped & dried roots and 5 % molasses. Taking into account the potential yields of separate cropping experiences with intensive leaf production (between 10–50 tons every three months) and intensive root production (20–30 tons every 12 months), the approximately cropping area for each material should be calculated.

After the cassava roots and leaves crops have been collected, the material has to be chipped and dried. The stems can be dried as whole stems (hay) or chipped and dried.

Experimental animals

Milking cows will be included in a feeding demonstration where most of the daily feed will be provided by the cassava leaf/root mixture. One control group under the standard feeding conditions should be included, if possible.

Sanitary and management conditions will be the same in all groups. Ad libitum feed will be provided for all treatments. Milking cows may remain on grazing conditions or semi–confined conditions.

Experimental diets

The dried cassava diets will be prepared at the farm facilities under the supervision of Tafic technicians.
The control group will be fed a normal commercial diet or the normal grazing program at the farm level.

The dried leaf/root mixture will be provided every day to the experimental animals. 5% molasses will be added on top of the cassava mixture in order to stimulate a larger consumption. Feed consumption will be based on farm variables, including the type of animals and the local productivity. For high yielding cows an approximate total consumption per cow/day will be based on 2–3% of the body weight to provide the needed nutrients for semi-confined animals (i.e. a 400 kg cow may consume between 8 to 12 kg of the total dry mixture).

If animals receive some grazing or green forage, less silage will be consumed and the adjustments should be introduced according to the farm management program.

All animals should receive a mineral–salt mixture and clean water as a complement to silage.

Experiment controls

Records of individual weight of cows at first and last day of the experiment.
Daily milk production per cow.
Daily feed consumption per cow.
Sanitary conditions of cows.

Costs: Cost (per kilogram) of commercial and experimental diets.
Total production costs

Daily feeding program in total or semi-confined conditions

The mix 80% : 15% : 5% dry leaves, dry roots and molasses ratio has been proposed as a balanced energy : protein mixture which will provide most nutrients for lactating cows under confined or semi-confined conditions. If other feed resources (forages, molasses, pasture, urea, etc.) are included, the ratio and/or daily consumption should be changed.

i.e: A 400 lactating cow will need around 8–12 kg of the proposed cassava mixture. This mixture will provide around 1,500 grams of protein and 8.1 kg of TDN per day.

Ad libitum mineralized salt should be provided or an approximate daily allowance of 120–150 grams per head.
Starting date of trial.
Ending date of trial.

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<th></th>
<th>MONTH 1</th>
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<td>Second broiler and feed</td>
<td>Third broiler and feed</td>
<td>Last records on weight and feed</td>
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<td>Prepare Control formats</td>
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<td>analysis</td>
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</table>
### FORMAT 1 / BROILER

**Day 1:**  
- Initial No. birds  
- Total weight at day 1 (all birds)  
- Av. Wt.  
- Total feed consumption for the period  
- Feed conversion

**Day 21:**  
- Number of birds  
- Mortality  
- Total weight at day  
- Av. Wt.  
- Total feed consumption for the period  
- Feed conversion

**Day 42:**  
- Number of birds  
- Mortality  
- Body wt. for sample of broilers  
- Av. Wt.  
- Total feed consumption for the period  
- Feed conversion

**Last day:**  
- Number of birds  
- Mortality  
- Total weight at last day (all birds)  
- Av. Wt.  
- Total feed consumption for the period  
- Feed conversion

### FORMAT 2 / BROILER

**Day 1:**  
- Initial No. of birds  
- Total weight at day 1 (all birds)  
- Av. Wt.  
- Total feed consumption for the period  
- Feed conversion

**Last day:**  
- Number of birds  
- Total Mortality  
- Total weight at last day (all birds)  
- Av. Wt.  
- Total feed consumption for the period  
- Feed conversion

132
Cost per kg of every diet
Cost of feed per bird
Price for kg of broiler
Price per bird
Other costs
Cost: benefic ratio per treatment

**FORMAT 1 / LAYERS**

**Day 1:**
Initial No. of birds
Total weight at day 1 (all birds)
Av. Wt.

**Day 15:**
Number of birds
Mortality
Total feed consumption for the period
No. of eggs produced
Weight for sample of eggs
Ave. wt. of eggs
Yolk color grading
Feed conversion

**Day 30:**
Number of birds
Mortality
Total feed consumption for the period
Feed conversion
No. of eggs produced
Weight for sample of eggs
Ave. wt. of eggs
Yolk color grading

**Day 45:**
Number of birds
Mortality
Total feed consumption for the period
Feed conversion
No. of eggs produced
Weight for sample of eggs
Ave. wt. of eggs
Yolk color grading

**Last Day:**
Number of birds
Mortality
Total weight at last day (all birds)
Av. Wt.
Total feed consumption for the period
Feed conversion
No. of eggs produced
Weight for sample of eggs
Ave. wt. of eggs
Yolk color grading

**FORMAT 2 / LAYERS**

**Day 1:**
Initial No. birds
Total weight at day 1 (all birds)
Ave. Wt.

**Last day:**
Number of birds
Mortality
Total weight at last day (all birds)
Ave. Wt.
Total feed consumption for the period
Feed conversion
No. of eggs produced
Weight for sample of eggs
Ave. wt. of eggs
Yolk color grading

Cost per kg of every diet
Cost of feed per bird
Price per 100 eggs
Price for kg of eggs
Price of feed per 100 eggs
Price of feed per kg of eggs
Other costs
Cost: benefit ratio per treatment

**FORMAT 1 / DAIRY**

**Day 1:**
Initial No. of cows
Total body weight of each cow
Ave. Wt.

**Day 15:**
Total feed consumption for the period
Kg of milk produced
Ave. milk production/cow
Feed conversion

**Day 30:**
Total feed consumption for the period
Kg of milk produced
Ave. milk production/cow
Feed conversion

134
Day 45:
Total feed consumption for the period
Kg of milk produced
Ave. milk production/cow
Feed conversion

Last day:
Total feed consumption for the period
Kg of milk produced
Ave. milk production/cow
Feed conversion

FORMAT 2 / DAIRY

Day 1:
Initial No. of cows
Total body weight of each cow
Av. Milk production / day

Last day:
Total body weight of each cows
Total feed consumption for the period
Feed consumption per cow / day
Kg of milk produced
Ave. milk production/cow/day
Feed conversion

Cost per kg of feed
Cost of feed per cow / day
Cost of feed per kg of milk produced
9.7. Demonstration trial with ensiled cassava roots and leaves for diary feeding in the Lilongwe milkshed area (Malawi)

Planning: Sarrnet–Land O’Lakes

Execution: Vito Sandifolo / France Gondwe / Austin Ngwira

Location: Agricultural Research Station
Lilongwe
m.s.n.m. 28–30 oC

9.7.1. Objectives

- To evaluate a feeding program for diary cows totally based on cassava roots and leaves silage plus a mineral supplement.

- To calculate the cropping area needs for both intensive cassava forage and intensive root production for a dairy operation based on cassava as the principal feed resource.

9.7.2. Materials and Methods

Cropping area and ensiling procedure

The final daily diet will be based on a leaves-to-roots ratio equivalent of 80 % fresh leaves and 20 % fresh roots. Taking into account the potential yields of separate cropping experiences with intensive leaf production (between 10–50 tons every three months) and intensive root production (20–30 tons every 12 months), the approximately cropping area for each material should be calculated.

Since the daily diet will be provided in an ad libitum basis of a silage mixture, the ensiled formulation should be prepared following the same proportion: 80 % leaves + 20 % roots.

After the cassava roots and leaves crops have been collected, the material has to be chipped, mixed, packed and ensiled in plastic bags or aerial silo. The bags and/or the silo should be packed and sealed trying to eliminate as much air as possible from the ensiled material.

The ensiled mixture will be stored for a minimum of three weeks in order to complete the silage process. After three weeks, the bags and/or silo will be opened according to the daily feeding needs. The remaining bags can be opened every day until a new silage is prepared. The ensiled product may remain for at least one year, if the ensiled mixture has been properly prepared and stored.
Experimental animals

Milking cows will be included in a feeding demonstration where most of the daily feed will be provided by the ensiled cassava leaf/root mixture. One control group under the standard feeding conditions should be included, if possible.

Sanitary and management conditions will be the same in all groups. Ad libitum feed will be provided for all treatments. Milking cows may remain on total confinement or semi-confined conditions.

Experimental diets

The cassava silage will be prepared at the farm facilities under the supervision of SARRNET technicians.

The control group will be fed a normal commercial diet or the normal feeding program at the farm level.

The ensiled cassava leaf/root mixture will be provided every day to the experimental animals. Feed consumption will be based on farm variables, including the type of animals and the local productivity. For high yielding cows an approximate consumption based on 12 to 13 percent of the body weight should provide the needed nutrients for semi-confined animals (i.e. a 400 kg cow may consume between 45 to 52 kg of ensiled material).

If animals receive some grazing or other type of supplemental feed, less silage will be consumed and the adjustments should be introduced according to the farm management program.

Each animal should receive approximately 100 to 140 grams per day of a mineral-salt mixture and clean water as a complement to silage. Any of the following formulations for the mineral mixture is recommended:

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<th>Iodized salt</th>
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<tbody>
<tr>
<td>Calcium carbonate</td>
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<td>20.0 kg</td>
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<tr>
<td>Dicalcium phosphate</td>
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<td>Sulfur</td>
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<td>Zinc oxide</td>
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<td>Zinc sulphate</td>
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<td>2.5 kg</td>
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<td>Copper oxide</td>
<td>0.2 kg</td>
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<td>Copper sulphate</td>
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<td>0.5 kg</td>
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<td>Magnesium oxide</td>
<td>0.6 kg</td>
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<tr>
<td>Magnesium sulphate</td>
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<td>1.0 kg</td>
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</table>

**TOTAL** 100.0 kg 100.0 kg
**Experiment controls**

Individual weight records of cows at starting day and last day of the experiment.  
Daily milk production per cow.  
Daily feed consumption per cow.  
Sanitary conditions of cows.  

Costs: Cost (per kilogram) of commercial and experimental diets.  
Total production costs

Summary for the daily feeding program in total or semi–confined conditions

The 80 % to 20 % leaves to roots ratio has been proposed as a balanced energy : protein mixture which will provide most nutrients for lactating cows under confined or semi–confined conditions. If other feed resources (forages, molasses, pasture, urea, etc.) are included, the ratio and/or daily consumption should be changed.

The approximate amount of the ensiled mixture depend on several variables, but a total consumption based on 12 to 13 % of total body weight is recommended.

i.e: A 400 lactating cow will need around 45–50 kg of the 2:1 ensiled cassava mixture.  
This mixture will provide around 1,400 grams of protein and 8.2 kg of TDN per day.

*Ad libitum* mineralized salt should be provided or an approximate daily allowance of 100–140 grams per head.  
Starting date of trial.  
Ending date of trial.
10.0. Future activities

10.1. Proposal for a three–day training program in cassava and sweet potato usage as feedstuffs for ruminant and non–ruminant nutrition in southern Africa

(First draft)

10.1.1. Objectives

Provide up to date information on the nutritional characteristics of cassava and sweet potato byproducts and their potential in animal nutrition for Southern Africa.

To present up-to-date information on recently developed post–harvest and processing techniques for optimising the use of cassava and sweet potato in commercial diets.

Present different alternatives for ruminant and non–ruminant feeds based on cassava and sweet potato products.

10.1.2. Proposed participants

Animal Scientists and Agriculturalists with interest in cassava and sweet potato usage.

ONGs and government officials involved in agricultural and animal science development in Southern Africa.

Location

Dates

10.1.3. Conference program

Day 1

8:00–8:30  Inscriptions

8:30–9:00  Presentation and objectives

9:00–9:30  Potential for cassava and sweet potatoes as strategic feedstuffs sources for ruminants and non–ruminants animals in Southern Africa.

Sicco Kolijn / Dev Jani

9:30–10:00  Comparative advantages and limiting factors for the inclusion of cassava leaves and roots as a feedstuff for ruminants compared with traditional systems: extensive grazing, confined and semi-confined systems, maize silage, etc.

Julián Buitrago

10:00–10:30  Coffee brake
10:30-11:30 Comparative advantages and limiting factors for the inclusion of cassava leaves and roots as feedstuffs for non-ruminants compared with traditional sources: maize, maize by-products, rice by-products, molasses, cottonseed cake, sunflower cake, fish meal. Julián Buitrago

11:30-12:00 Discussion

2:00-3:00 Updated agronomical technology and new alternatives in cassava–animal feeding models: intensive root production, intensive leaf production and mixed root–leaf production. Bernardo Ospina

3:00-4:00 Post–harvest processing of roots and leaves in order to obtain commercial feed ingredients of potential use in poultry, swine and dairy. Sicco Koijn

Chipping of roots and leaves
Drying of roots and leaves
Sun drying for small processors
Artificial drying for industrial enterprises
Hay production from leaves
Silage preparation of cassava roots and leaves for dairy feeding
Silage preparation of cassava roots and leaves for swine feeding

4:00-4:30 Coffee break

4:30-5:30 Discussion

Day 2

8:00-9:00 Nutritional composition of cassava / sweet potato leaves and cassava roots/sweet potato tubers on fresh, dried and ensiled basis. Julián Buitrago / Dev Jani

9:00-10:00 Maximum levels of cassava leaves and roots as protein and energy sources in poultry, swine and dairy feeding: dry roots, dry leaves, fresh roots, fresh leaves, ensiled roots, ensiled leaves. Julián Buitrago

10:00-10:30 Coffee break

10:30-11:30 Discussion

2:00-4:00 Visit field trials for demonstrations on cassava processing: chipping, drying, root and leaf silage.

4:00-6:00 Visit animal feeding trials
Day 3

8:00–9:00
Results of feeding poultry and swine with cassava meal in Africa.
F. P. Lekule

9:00–10:00
Economical evaluation of feeding programs for poultry, swine and dairy based on cassava and sweet potato products.
Dev Jani / Salim Msellem

10:00–10:30
Coffee break

10:30–11:30
Final discussion

11:30–12:00
Wrap-up session
10.2. Training Workshop for Cassava/Sweet Potato Linkage Facilitators

**Background**

- Increased importance of cassava in Southern and Eastern Africa.
- Current and potential market opportunities for cassava (results of market studies).
- SARRNET phase 1 and phase 2, bilateral projects (e.g. Mozambique).
- Transition from market identification to market development.
- Importance of promoting linkages between farmers and industrial clients.
- Role of the "go-between".

**Audience**

- CFC national facilitators.
- SARRNET facilitators for Malawi, Zambia, Tanzania, Angola, Madagascar.
- CFC and SARRNET candidates. Other projects candidates.

**Strategy**

- This should be a quality course, rather than a quantity course, and it must be put in the context of "continuing" education.
- It should be considered as one-off training course (more part of a process which requires an attitude shift).
- Before the course, some activities must be done:
  - Careful selection of the candidates themselves (critical for the role that they will be fulfilling).
  - Preparation by the candidates themselves (always difficult).
  - Follow-up activities (study tours, refreshers, other specialized in-depth courses).

**Expected output**

By the end of the course, it is expected that we have a group of first class "catalysts and facilitators".

**Objective**

Following the course, the participants will have the capacity to act as a catalyzer and facilitator in:

- The process of identifying and making accessible to farmers, improved technologies for cassava and sweet potato based research and development activities.
- The process of developing links between farmer groups and new, alternative markets for cassava and sweet potato products and by-products.
- The process of promoting strategic alliances between public sector institutes, private sector enterprises and farmer groups, aimed at supporting cassava and sweet potato based, research and development activities.
Scope of the course

The course is designed to be implement as a sequence of modules that include:


- Conceptual framework and methodological steps of IRDPs
- Conceptual framework of PPPs for root crops Research and Development
- Experiences in Latin America and Africa
- Facilitation techniques and skills: bringing actors together and keeping them together
- Participation: the why, when and how of participation
  (2 days)

**Module 2. Enterprises and markets**

- Enterprises and entrepreneurship
- Basics of markets and marketing
- The market survey: identifying demand
- The market survey: commodity chain characterization
- Interview techniques
- Information collection, processing and documentation: the market report
  (2 days)

**Module 3. Root crops processing technology and utilization**

- Cassava and sweet potato as a food and raw material for industry
- Fresh and fresh prepared products
- Flour for the food industry and home consumption
- Starch and starch derived products for food and non-food industries
- Cassava and sweet potato in animal feeding
- Cost structures for processing
  (2 days plus 1–day field visit)

**Module 4. Root crops production technology**

- Competitive production systems and cost structures: cassava
- Competitive production systems and cost structures: sweet potato
  (2 days plus 1–day field visit)

**Module 5. The Business Plan**

- Preparing a business plan: theory
- Preparing a business plan: practice
  (2 days, using concrete cases visited during field visit)
Each Module to be accompanied by:

✓ Overview of module and summary of presentations,
✓ Copies of PowerPoint presentations,
✓ Information sources (bibliography),
✓ Manuals where available,
✓ Videos,
✓ Financial models

*Duration*: 12 days (estimate)

*Place*: Dar es Salaam or a place where three/four different types of root crop enterprise can be observed and used as case studies for business plans.

*Resources required:*

**Human resources**

Persons with knowledge skills in the following areas:

- ICRDP and PPP approaches.
- Facilitation and participatory skills.
- Markets and marketing, with particular knowledge of cassava and sweet potato markets.
- Technical knowledge of cassava and sweet potato processing and utilization (general, rather than detailed, the detailed knowledge would have to come in specialized courses later).
- Technical knowledge of cassava and sweet potato commercial production systems with in-depth understanding of costs and cost structures. In depth knowledge of production technologies would have to come later.
- Business plans.

**Materials:**

All the usual: video beam, overhead projector, flip charts, cards, markers, tape, 4 computers for group work, diskettes, ball points pens, pads, ring folders for handouts, computer for secretarial back-up, secretary/assistant for logistics, etc.

**Budget:**

**Detailed program:**

For further information contact

Who will be the general coordinator.
Should we make different persons responsible for different modules, with an overall coordinator.