I. Project Overview

Groundnut is a key legume crop throughout the Eastern and Southern Africa region, grown mainly by smallholder farmers. Groundnuts are extensively grown throughout Malawi and Tanzania providing an opportunity to lift large numbers of people out of poverty. The crop is currently grown on 710,000 ha in the two countries, serving more than 2.8 million households. Groundnuts are nutritious (high protein [12-36%], high oil content [36-54%]), thrive under low rainfall and poor soil fertility conditions (it fixes atmospheric nitrogen), and can be grown with low capital investment. Groundnut also makes an important contribution to soil fertility, which is the major limiting factor to crop productivity in the two countries. Groundnut fodder is also highly nutritious as livestock feed. The Malawi and Tanzania Poverty Reduction Strategy Papers (MPRS 2007, TPRS 2011) reported that more than half of the populations in these two countries live below the poverty data line. Rural poverty is estimated at 52.4% (Malawi) and 34% (Tanzania). Groundnut is popular and widely traded in local, regional, and international markets. The introduction of improved groundnut varieties along with proven technologies for the management of aflatoxin contamination could have an especially important impact for women farmers who generally tend to be excluded from growing traditional cash crops, notably tobacco. The crop can help overcome severe nutrition deficiencies reported in the two countries where more than 50% (Malawi) and 35% (Tanzania) of children under five in the rural areas are malnourished to such a degree that their development is retarded. In fact child mortality rate is as high as 133 and 81 per 1000 live births in Malawi and Tanzania respectively (MPRS 2007, TPRS 2011). These rates are among the highest in the world, and the major causes of death are malaria and malnutrition. This severe malnutrition has several causes. First, the rural poor do not produce enough food to feed themselves, but even when they do, the diet of the vast majority of farmers lack protein, oil and vitamins. Oil is necessary for absorption of vitamin A, the lack of which is highly prevalent. Groundnut is high in both protein and oil. These nutrients are especially important for growing children. But mycotoxin contamination in groundnut can mask the effects of the good nutrition provided by groundnuts.

Major constraints to groundnut production in the two countries include biotic (diseases/pests and aflatoxin contamination), abiotic (drought, poor soil fertility), socio-economic, and institutional. Diseases are generally considered to be the major constraints to increased production whereas aflatoxins are known to be carcinogenic and immunotoxic causing growth retardation. In sub-Saharan Africa, mycotoxin contamination is widespread in staple crops (groundnut, maize, millet, wheat, rice, sorghum, and soybean), in certain processed food and feed, and even in milk and meat products, where animals are fed with contaminated feed. Due to its comparatively high potential for causing harm to human and animal health, aflatoxin contamination of groundnut, maize and milk has gained global significance in the last four decades. Dietary aflatoxin, produced by the fungi *Aspergillus flavus and A. parasiticus,* retards growth and productivity in both humans and animals. Further, poor nutrition usually attributed to food insecurity which may be exacerbated by exposure to aflatoxins, can increase disease prevalence (Hepatic cellular carcinoma, hepatitis B and C and, possibly, the progression of Human Immunodeficiency Virus [HIV] to full blown Acquired Immune Deficiency Syndrome [AIDS] and related conditions) and further reduce the ability of humans to cope with mycotoxin exposure. Aflatoxins cause immuno-suppression due to the reactivity of aflatoxins with T-cells, decrease in Vitamin K activities and decrease in phagocytic activity in macrophages. Exposure to aflatoxins can aggravate the already delicate health of smallholder populations, such as those in many areas of Malawi and Tanzania, who subsist on legume and cereal-based diets and on milk from their livestock.

Establishment of the scale of mycotoxin exposure would help in the development of appropriate policies to mitigate the problem; similarly, the use of the right pre- and post-harvest management practices and development of aflatoxin resistant varieties would be vital to minimizing contamination.

II. Narrative Report

Partner Institutions

- The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
- The National Smallholder Farmers' Association of Malawi (NASFAM) - Malawi
- Kamuzu Central Hospital - Malawi
- The Department of Research and Development (DRD) of the Ministry of Agriculture and Food Security - Tanzania
- Sokoine University of Agriculture - Tanzania

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This report highlights achievements of Year 1, Phase II under the four main expected outputs for Malawi and Tanzania as follows:

- High yielding farmer and market-acceptable groundnut varieties with resistance to foliar/viral diseases and aflatoxin contamination developed;

- Nutritional status, dietary diversity, human health and mycotoxin contamination problem spatially characterized;
- Adoption rates of improved farmer and market-acceptable varieties and production technologies enhanced; and
- Capacity of partners for management of mycotoxins in food, variety development and enabling policy environment enhanced.

Objective 1: High yielding farmer and market-acceptable groundnut varieties with resistance to foliar/viral diseases and aflatoxin contamination developed

Progress will be reported under three major activities responding to this objective: germplasm identification and trait introgression, development of breeding populations with special emphasis on screening for groundnut rosette disease and fungal foliar diseases, and variety development for aflatoxin resistance.

1.1. Identify germplasm and introgress traits for yield components, farmer/market preferences, and adaptation to biotic and abiotic (drought) resistance/tolerance

A number of germplasm lines with good resistance to Groundnut Rosette Disease (GRD), Rust and Aflatoxin were identified from introductory nurseries in this season. These materials have formed a basis for new hybridization activities in Phase II. For GRD resistant lines included: ICG 14705, ICG 13099, ICG 9449 and ICG 15405; for Rust: ICGV 02194, ICG 11426, ICGV 01276 and ICGV 02286; and for Aflatoxin: J11, Ah 7223, ICGV-SM 02538, ICGV 92280 and ICGV 95494. A crossing program is planned beginning this winter whereby these new sources are expected to form the basis of new hybridization activities for Phase II.

1.2. Develop diverse groundnuts breeding lines and populations while developing capacity to screen for GRD and foliar disease resistance

The project continued with efforts to avail more sources of resistance to both biotic and abiotic constraints and build up on successes made in Phase I. In Malawi, a number of nurseries ranging from preliminary to regional trials were screened under different environments: twelve (12) nurseries for Early Leaf spot (ELS) under high disease pressure, and fourteen (14) nurseries for groundnut rosette disease (GRD) under high disease pressure at Chitedze Research Station; seven (7) nurseries under rust disease pressure at Chitala Research Station, and seven (7) nurseries under drought stress at Ngabu Research Station. For ELS, GRD and Rust, high disease pressure was achieved through use of the infector row technique as well as repeated aphid seeding in the case of GRD. A subset of the nurseries was also evaluated in Tanzania under normal field conditions without inoculation. Those sent to Tanzania included the Elite Regional Drought Resistant Variety Trial lines (20), Elite Rust Resistant Variety Trial lines (25), and Regional Rust Resistant Variety Trial lines (16). A nursery comprised of rust and late leaf spots segregating populations (2010 entries) in F4 generation was also provided for NARS Tanzania for screening to make their own line selections. In Malawi, ICGV-SM 05611 was the best line from the Regional Rust Resistant Variety Trial (1194.4kg/ha at Chitala) and (802kg/ha at Ngabu) out-performing the check ICGV-SM 90704 in both locations while 86-87/175 (b), ICGV-SM 05569, and ICGV-SM 06735 were the most resistant varieties with a rust score of 1-1.5, on a 1-9 disease rating scale compared to a score of 6 for the check ICGV-SM 90704. ICGV-SM 05569 and ICGV-SM

05611 seemed to combine both yield and disease resistance ability (827.8kg/ha to 1194 kg/ha and rust score of 1 and 2.5) respectively. From the Regional Drought Resistant Groundnut Varieties Trial, ICGV-SM 03520 and ICG 14788 were seen to be the best varieties giving yields of 1058 kg/ha and 1062kg/ha respectively, compared to 873kg/ha for the check JL 24. ICG 14788 had the largest seed in the trial and significantly better than JL 24 (45 g/100 seed mass vs. 31g/100 seed mass). In Tanzania, CG 7, ICGV-SM 05570, ICGV-SM 06711 had the highest pod yield in the Regional Rust Resistance variety trial while ICGV-SM 08573, ICGV-SM 08586, and ICGV-SM 08582 gave the highest pod yield (>1600kg/ha) in the Elite Rust Resistance variety trial. At Naliendele the main research location for oilseed crops, the best varieties in the study were ICGV-SM 08588, ICGV-SM 08587, ICGV-SM 08582, ICGV-SM 94114 and ICGV-SM 08573, all giving a pod yield of >3000kg/ha from the Elite Rust Resistant groundnuts variety trial. Varieties ICGV 94114, CG 7, ICGV-SM 05570, ICGV-SM 90092, ICGV-SM 07570 and ICGV-SM 06711 had high pod yield at Naliendele in the Regional Rust Resistant groundnuts variety trial. ICGV-SMs 94114 and 90092 presented good levels of resistance to rust in Tanzania while ICGV-SM 05520 and 86-87/175 (b) were resistant to rust in Malawi. ICGV-SMs 03520 and 14788 performed well under extreme drought conditions in Southern Malawi (our drought field screening site - Ngabu).

1.3 Develop advanced breeding lines and varieties of groundnut with special emphasis on resistance to aflatoxin contamination

Efforts to screen lines for aflatoxin resistance are underway in Malawi. A potted trial for screening and developing lines and varieties (24 + check) resistant to aflatoxin contamination has been established at Chitedze Research Station. The experiment arranged in a Randomized Complete Block Design was exposed to two treatments under controlled environment; irrigation and water stress each replicated twice. Results are expected in the next reporting period.

Objective 2: Nutritional status, dietary diversity, human health and mycotoxin contamination problem spatially characterized

2.1 Assess aflatoxin load in exposed populations and relationships to health related ailments

Based on the outcomes of the aflatoxin survey conducted in Malawi, the Project Team from Kamuzu Central Hospital selected two districts of Mchinji and Salima for blood samples collection. Salima was among the few drought prone districts which had high levels of aflatoxin contamination while Mchinji is one of the major groundnut producing districts with significant consumption, and therefore high potential for contamination. Participants in this activity included both vulnerable and non-vulnerable groups. The team embarked on a sensitization campaign and with the assistance of medical officers working in the selected communities outlined the scope and objectives of the study.

The project managed to procure all required medical equipment for blood sampling. The activity, which is in progress, was commenced in July 2011. In Mchinji, ninety six (96) blood samples were collected from three communities: Kalulu (17), Chiosya (36), and Mkanda (43); while forty six (46) samples were collected from Salima: forty four (44) from the

District Hospital, and two (2) from Makoni Village. The collected samples are currently at Kamuzu Central Hospital and once the collection is complete, analyses for aflatoxin loads will commence. The team also plans to start umbilical sample collection and biopsy procedures in November 2011.

2.2 *Assess aflatoxin load in exposed populations and relationships to nutrition as determined by body mass index (BMI).*

The nutrition survey targeted two districts in Tanzania: Chamwino and Bahi. From Chamwino, a predominantly sorghum/maize growing village (Muungano) was selected whereas in Bahi, a predominantly millet growing village (Mundemu) was selected. In Mundemu village, about 80% of mothers use finger millet and pearl millet for complementary foods preparation, but in Muungano, 85 - 90% of the mothers admitted using sorghum or pearl millet to make complementary foods and 50% admitted to mostly using maize. It was also shown that most mothers (80%) in Muungano and Mundemu villages start providing complementary foods to their children at the age of six months compared to 20% that start complementary feeding at the age of three and four months. This finding will help develop entry point for dietary formulations.

Objective 3: Adoption rates of improved farmer and market-acceptable varieties and production technologies enhanced

3.1. Conduct participatory adaptive trials to assess mycotoxin management practices relating to crop production in pre- / post-harvest operations, and demonstrations for post- harvest handling, food processing methods, consumption patterns and diets

Thirty seven (37) farmer friendly options for the management of aflatoxin and GRD were successfully demonstrated at farmer fields in Malawi. For Participatory Variety Selection, thirty (30) mother trials and forty two (42) baby trials were established at fifteen farmer groups (each group having 15 farmers) in Malawi. Participatory Variety Selection in Tanzania was conducted on farm in villages representing groundnut growing areas. The villages included Nahawara, Nangomba in Nanyumbu district; Namombwe and Chikoweti in Masasi District; and Naluwale and Luanda in Tunduru district. In Malawi, most farmers preferred ICGV-SMs 99722 and 99551 while in Tanzania the farmer preferred varieties were ICGV-SMs 01731, 02724 and 02715. The varieties are different in the two countries because entries promoted for on-farm verification were also different. However, farmers in both countries showed preferences for both Spanish and Virginia type varieties.

3.2. Conduct field days, agricultural shows & rural seed fairs with farmers, researchers & market players to promote improved mycotoxin management including testing of resistant cultivars

Two (2) field days (Malawi) and 1 field day (Tanzania) were conducted engaging various stakeholders in order to increase understanding on issues of aflatoxin and groundnut production technologies demonstrated on farmers' fields as well as eliciting views on varieties under on-farm trials. The field days were conducted from 28 to 30 April 2011 in Malawi and from 6 to 7 May 2011 in Nanyumbu district Tanzania. The field days were attended by a total of 897 farmers (797 in Malawi and 100 in Tanzania). From the Malawi group, 371 were males and 426 were females.

3.2.1. Enhance institutional innovations to improve access of the poor to good quality seeds of improved high yielding adapted varieties

In Malawi (Mchinji in particular), ninety (90) community seed banks with membership of 2970 farmers are operative. Twenty additional community seed banks were established in Mikundi, a new project site in Mchinji district and similar efforts are underway in Mzimba district. Most farmers under this program have planted more than an acre each of groundnut of the improved variety *Nsinjiro* (ICGV-SM 90704) as a result of improved access to seed of this variety. In Tanzania fifty (50) Farmer Research Groups were involved in seed multiplication and in the past season a total of forty (40) tons of groundnut seed of the variety Pendo was produced by the groups.

3.3. Market players to promote improved mycotoxin management including testing of resistant cultivars

The project engaged the Department of Agriculture and Nutrition at Ekwendeni Hospital in the project's new district, Mzimba, to help promote technologies for the management of aflatoxin. The Department works with over nine thousand (9000) farming families and has well-established structures with the primary aim of uplifting the livelihood of farmers with limited resources, using various enterprises including groundnut farming. The on-farm trials and demonstrations for the management of aflatoxin introduced to farmers in this community knowledge about aflatoxin contamination and how to manage the problem. Being an organized group focusing on agriculture and nutrition this group already has experience in collective production for markets, and therefore, the addition of aflatoxin management knowledge would further enhance their marketing skills and improve household nutrition security as well.

Objective 4: Capacity of partners for management of mycotoxins in food, variety development and enabling policy environment enhanced

4.1. Stakeholders project start-up/ planning workshop to agree on project components for promotion, pilot areas and mode of operation

A stakeholders' planning workshop was held at Club Makokola in Mangochi in Malawi from 2-4 October, 2010. The objective of the workshop was to look at lessons learnt from Phase I and use them as a launch pad for Phase II. Topics, such as Protocols for groundnut breeding for Malawi and Tanzania, Nutrition component from Sokoine University, and Health component from Kamuzu Central Hospital were reviewed and refined.

4.2. Training workshops for NARES staff

Three (3) project staff from Naliendele Agricultural Research Institute received hands-on training on how to conduct aflatoxin disease survey. The survey was then carried out in Mtwara, Dodoma and Shinyanga regions with support from an ICRISAT social economist, Harry Msere from 19 May to 5 June, 2011.

4.3. Degree training program to MSc students to develop regional capacity for pathology work including screening of commodities for aflatoxin contamination

A student (Athanas Minja) for MSc training has been identified in Tanzania. This training is expected to improve capacity in the region for pathology work. The candidate has been registered with Sokoine University of Agriculture. Arrangements have also been made with the University of Georgia and the Peanut Science Research Laboratory at Dawson, Georgia, for a second candidate (Ethel Chilumpha from Malawi) to study the *Aspergillus flavus* infection mechanism signal and aflatoxin production in the groundnut host with the aim of acquiring knowledge on biological control strategies that are in use. The project also trained two team members – a medical doctor from Kamuzu Hospital (Dr Tiyamike Chilunjika) and a Senior Research Technician from ICRISAT (Ms Ethel Chilumpha) on aflatoxin analysis of blood samples to deal with the current project needs. The training was conducted at ICRISAT Headquarters in India from 24 September to 14 October 2010.

4.4. Conduct sensitization workshop for policy makers, NARES/ NGO/ private sector

4.4.1. Linkages with the health and other sectors will be developed and maintained for future collaboration

In collaboration with the Innovative Communication Media and Methods (ICMM) project, a stakeholders' workshop was organized in Tanzania on 7 June, 2011 and in Malawi on 17 June, 2011. The aim of the workshop was to share knowledge about aflatoxin in the food chain, how it affects human health and nutrition, and also its effects on trade. The workshops were attended by lead farmers, farmer organizations, agricultural extension officers, researchers, traders, processors, medical personnel and communication media (radio). The workshops were conducted in the local languages of both countries in order to increase understanding and enhance knowledge exchange. The team presented the aflatoxin problem, how it infests the crop in the field, crop management strategies to control the problem and its effects on human health, nutrition and trade. The medical doctors in both countries (Kamuzu Hospital in Malawi and Arusha Lutheran Medical Center in Tanzania) went into details on the links between aflatoxin and diseases, especially some cancers. This explanation, from a medical point of view, grabbed the maximum participant attention; subsequently the radio and media recording were widely broadcast, particularly through community and national radio. Participants were shown the fungus (*Aspergillus flavus*) through microscopes on the otherwise clean groundnuts resulting from poor post-harvest handling of the commodity, which admittedly was the first time many of them actually got to see the fungus on the groundnut.

4.4.2. Develop and share project reports, policy briefs and journal articles

In Tanzania the project in collaboration with the Zonal Communication Office sensitized stakeholders on production and marketing of improved technologies including improved seeds, management of foliar diseases and aflatoxin through radio, TV programs, and the production of posters. This effort resulted in 20 radio programs and 10 TV programs being produced and broadcast by Tanzania Broadcasting Corporation (TBC) nationally. In Malawi, 1500 flyers aimed at sharing findings of research activities (PVS, options for the management of rosette and aflatoxin) from the first phase were distributed to various stakeholders during farmer field days in Mchinji, Nkhotakota and Mzimba.

4.5. Establish strategy and time frame for impact monitoring and reporting

The project team held a planning meeting at the onset of the second phase to develop a monitoring and evaluation tool to facilitate appropriate and timely implementation of activities. The team critically looked at project indicators and developed a time frame while focusing on the milestones, methods of data collection, who to collect what data, frequency of reporting and use of information generated by specific activities. The meeting also considered the basic M&E questions to be used as a probing guide so as to help information users develop the right intervention strategies and the use of proper impact assessment tools. The meeting took place on 7 September 2011 at the ICRISAT Malawi Office and it went through the plan and completed the project's Theory of Change (TOC) with the support of the Regional Impact Monitoring Officer, Ms Carolyne Nombo.

Challenges

- We have identified new sources of resistance to GRD from the global groundnut reference set germplasm. However, we still have not been able to confirm which of the three resistance components (Sat RNA, GRAV and/or GRV) is responsible for the resistance observed. Our pathologist is currently working on this area.
- Screening for aflatoxin resistance at field level is complicated in that we cannot add innoculum in the field to increase or adjust for uniform disease pressure. We are not sure whether our screening in pots is representative enough of field conditions because of the confined environment.
- Our project is the first of its kind in Malawi looking at the aflatoxin load in humans. Purchase of equipment and reagents for this type of research has been a challenge because everything has to be imported. As a result we still have not been able to get all the required equipment and reagents imported into Malawi.
- It took more than six months to get the National Health Sciences Research Committee's approval to work on human beings since it had to be proved that the project has taken care of all ethical considerations necessary for conducting experiments on humans.
- Dodoma is one of the driest districts in Tanzania. We worry if the selected households do not harvest enough grain due to drought, it may interfere with the success of the planned nutrition studies.
- Farmers do not get a better price for their commodities that have suitably addressed the aflatoxin problem. Therefore, they do not have much incentive to do so.
- Collection of blood samples from the community for research purposes is a new and sensitive undertaking. The team embarked on intensive sensitization to increase awareness and thus improve sampling success.
- Some mothers under the nutrition component of the project are illiterate, which prevents them from reading the training manuals.

Insights and lessons learned

- Once sources of resistance are identified they should also be evaluated for performance and farmer preference per se to determine whether they can be promoted for release. One such example is ICG 12991 identified as a source of GRD through resistance to the aphid vector in 1999, and now released in three countries including Malawi, Mozambique and Uganda. Where the sources of resistance do not have enough appeal to be released as they are, then the resistance they carry should be introgressed into adapted farmer/market preferred varieties.

- When screening for resistance to colonization by *A. flavus* it is important to first determine the amount of *A. flavus* in each pot and adjust the concentration so that each pot has similar amounts. The *A. flavus* concentration in the pots also need to be determined immediately after harvesting and related to the aflatoxin contamination in the grain.
- Due to differences in phenology it is important to screen Spanish and Virginia germplasm for aflatoxin infection in different trials.
- Since reagents and consumables have to be imported, it is important that a bulk purchase is done so as to avoid running out of reagents and then having to wait for imports to arrive.
- Farmers do not get a better price for their commodities even after taking care of the aflatoxin problem. As such they do not have much incentive to do so.
- We learned that to succeed in getting community members volunteer their blood for testing, it is important that we contact the same communities from whom we had collected grain samples for aflatoxin testing, and the same staff who interviewed farmers during the grain collection should introduce the medical personnel. This would highlight to the community that this is the same study which was now determining if the problem is affecting people the same way it affected the grain.
- We learned that participants in the blood sample exercise are eager to get results on aflatoxin loads in their blood. This enthusiasm will encourage more people to come forward for the test.
- Training of trainers program will establish expertise at the community level so that the mothers who cannot read the manual prepared for nutritious recipes have practical training from fellow lead farmers of the same village.
- Introgression of aflatoxin resistance into farmer-preferred varieties is a more viable option than developing new varieties with resistance to aflatoxin.
- Farmers from both countries are willing to participate in project activities.
- Selected mothers for the nutrition exercise were very excited to be selected for participation in the project and are eager to learn how to improve their complementary foods using groundnuts.
- The aflatoxin workshop showed consensus on the need for concerted efforts for action against aflatoxin contamination in crops and food products.

III. Annual Workplan

DETAILED WORKPLAN FOR YEAR 2 (Sept 2011 – Aug 2012)

Project Outputs and Activities

Objective 1: High yielding farmer and market-acceptable groundnut varieties with resistance to foliar/viral diseases and aflatoxin contamination developed

1.1 Identify and introgress germplasm for yield components farmer/market preferences and adaptation to biotic and abiotic (drought) traits.
1.2 Develop diverse groundnuts breeding lines and populations while developing capacity to screen for GRD and foliar disease resistance in Tanzania.
1.3 Develop advanced breeding lines and varieties of groundnut with special emphasis on resistance to aflatoxin contamination.

Objective 2: Nutritional status, dietary diversity, human health and mycotoxin contamination problem spatially characterized

2.1. Define the scale of the mycotoxin contamination problem and identify the hotspots depicting pockets of the populations where mycotoxin occurrence is higher (TZ)
2.2. Assess the relative exposure of humans to mycotoxin contamination of food in drought prone regions and other vulnerable areas and nutritional benefits from aflatoxin free foods (TZ)
2.3. Assess aflatoxin load in exposed populations and relationships to health related ailments (MW)
2.4. Assess aflatoxin load in exposed populations and relationships to nutrition as determined by body mass index (BMI). (TZ)

Objective 3: Adoption rates of improved farmer and market-acceptable varieties and production technologies enhanced

3.3. Conduct participatory adaptive trials to assess mycotoxin management practices relating to crop production in pre- / post-harvest operations, and demonstrations for post-harvest handling, food processing methods, consumption patterns and diets
3.4. Conduct field days, agricultural shows & rural seed fairs with farmers, researchers & market players to promote improved mycotoxin management including testing of resistant cultivars
3.4.1. Enhance institutional innovations to improve access of the poor to good quality seeds of improved high yielding adapted varieties

Objective 4: Capacity of partners for management of mycotoxins in food, variety development and enabling policy environment enhanced

4.1. Stakeholders project start-up/ planning workshop to agree on project components for promotion, pilot areas and mode of operation (start-up workshop completed, planning workshop annually)
4.2. Conduct training workshops for NARES staff
4.3. Degree training program for MSc student to develop regional capacity for pathology work including screening of commodities for aflatoxin contamination
4.4. Conduct sensitization workshop for policy makers, NARES/ NGO/ private sector
   4.4.1. Through a national level workshop recommended policy options will be advocated to decision-makers at the national level by end of project. Preliminary findings will be shared with stakeholders.
   4.4.2. Linkages with the health and other sectors will be developed and maintained for future collaboration
   4.4.3. Develop and share project reports, policy briefs and journal articles
4.5. Establish strategy and time frame for impact monitoring and reporting

Year	Quarter	Activity number	Type of milestone	Description of Milestone	Time due*	Means of verification	RESPONSIBLE ORGANIZATION AND INDIVIDUAL
1 1 1	1 3 4	1.1.1	Activity	• Breeding objectives incorporate knowledge and skills of smallholder farmers through PVS, thereby improving breeding efficiency from Year 1 of Phase II. (2011) • Additional sources of resistance to foliar diseases and or aflatoxin contamination identified from the groundnuts reference set, core collections, local and wild germplasm (2010 – 2014) • Farmer preferred varieties with local adaptation identified and hybridization initiated for introgression of resistance to aflatoxin, GRD and foliar fungal disease resistances (2012)	Nov 2011 June 2012 Sept 2011	• List of farmer researcher groups in the two countries • List of sources of resistance for hybridization • List of varieties with farmer / market preferred traits	• Selected smallholder farmer groups • ICRISAT (ESM)* • DRD (OM & EK) • NASFAM (BC & SJ) (ICRISAT[a], DRD [b] and NASFAM [b])

Year	Quarter	Activity number	Type of milestone	Description of Milestone	Time due*	Means of verification	RESPONSIBLE ORGANIZATION AND INDIVIDUAL
1	1	1.1.2	Activity	• Disease screening capacity developed in TZ, and NARS scientists routinely use the infector row technique (2010-2014)	Nov 2011	• Training reports • Aphid rearing initiated by Nov 2011	• ICRISAT (ESM)* • DRD (OM & EK) (ICRISAT[a], DRD [b]
1 1	3 4	1.1.3	Activity Activity	• Advanced breeding lines and breeder seed of improved groundnut varieties available to NARS and NGOs in ESA in an annual basis (2010 – 2014) • Sick plots for resistance to aflatoxin contaminated developed and screening and testing activities initiated	June 2012 Aug 2012	• Seed requests/ signed MTAs • List and quantities of germplasm distribution by country • List of entries screened and report of performance	• ICRISAT (ESM)* • DRD (OM) (ICRISAT[a], DRD [b]
1	4	2.2.1	Activity	• Complete aflatoxin survey report for TZ – (Feb 2012)	Feb 2012	• Survey report	• ICRISAT (ESM)* • DRD (OM & EK) (ICRISAT[a], DRD [b]
	4	2.2.1	Activity	• Aflatoxin testing of survey samples from TZ completed – (Oct 2011)	Oct 2011	• Report of aflatoxin levels	• ICRISAT (ESM & SN)

Year	Quarter	Activity number	Type of milestone	Description of Milestone	Time due*	Means of verification	RESPONSIBLE ORGANIZATION AND INDIVIDUAL
	4		Activity	• *A. flavus* testing of soil and grain samples from TZ completed – (Feb 2012)	Feb 2012	• Report of A. flavus abundance in TZ soils	• ICRISAT (ESM & SN) • DRD (OM & EK) (ICRISAT[a], DRD [b]
	4	2.2.3	Activity	• Aflatoxin testing of human blood samples from MW – (Jan-March 2012)	March 2012	• Report of aflatoxin load in tested samples	• KCH (TC & FM) • ICRISAT (ESM) (KCH[a], ICRISAT [b]
1	4	2.3.4	Activity	• Initiation of BMI measurements linked to Post harvest project.	Jan 2012	• Progress report	• SUA (YM & ML) • ICRISAT (ESM) (SUA[a], ICRISAT [b]
1	4	3.1.1	Activity	• Varieties for wide scale on-farm adaptive testing with farmer participation (2010 – 2014)	Aug 2012	• List of varieties for on-farm testing in PVS in each country	• ICRISAT (ESM) • DRD (OM & EK) (ICRISAT[a], DRD [b]
1	4	3.2.1	Activity	• Field days, demonstrations, agricultural shows and seed fairs conducted at select farmer field school sites annually (2010 –	Aug 2012	• No of field days, number and type and stakeholders participating • No of demonstrations mounted	• ICRISAT (ESM) • DRD (OM & EK) • NASFAM (BC & SJ) (ICRISAT[a], NASFAM [b] DRD [b]

Year	Quarter	Activity number	Type of milestone	Description of Milestone	Time due*	Means of verification	RESPONSIBLE ORGANIZATION AND INDIVIDUAL
				2014)		• List of traders and others involved in g/nut trading • No of farmers demonstrating at seed fairs and list of varieties preferred by farmers & market	
1	1	3.3.1	Activity	• Engagement with at least two non-governmental organizations for community seed supply of improved groundnut varieties (2010 - 14)	Aug 2012	• Quantity of seed produced and sold	• ICRISAT (ESM) • DRD (OM & EK) • NASFAM (BC & SJ) (ICRISAT[a], NASFAM [b] DRD [b]
1 1	1 4 4	4.2.2	Activity	• Training partners in disease screening • Training partners in aflatoxin detection • Training new technicians on hybridization	Mar 2012 Aug 2012 Sept 2012	• Training report • Training report • Training report	• ICRISAT (ESM)

Year	Quarter	Activity number	Type of milestone	Description of Milestone	Time due*	Means of verification	RESPONSIBLE ORGANIZATION AND INDIVIDUAL
				techniques (Feb and Sept in alternative years as needed)			
1	4	4.5.1	Activity	• Project Annual Review for internal monitoring established and functioning (Oct-Nov 2010 - 2014)	Dec 2011	• M&E plan • Progress reviews and annual work plans	• ICRISAT (ESM) • DRD (OM & EK) • NASFAM (BC & SJ) (ICRISAT[a] KCH[b] NASFAM[b] DRD[b])

* The first named team member is the suggested leader for the delivery of the milestone. [a] responsible organization, [b] collaborating organization. MW=Malawi, TZ=Tanzania

BC = Betty Chinyamunyamu, SJ = Sella Jumbo, ESM = Emmanuel Monyo, EK = Elly Kafiriti, SN = Sam Njoroge, OM = Omari Mponda, TC = Tiyamike Chilunjika, FM = Frank Madinda, YM = Yasinta Muzanila, ML = Monica Lyimo

IV. BUDGET – see Financial Report

V. Appendixes

Appendix A. Research Report

Executive Summary

The McKnight CCRP groundnut breeding project supported by the McKnight Foundation is in its second phase (1 September 2010 – 31 August 2014) of implementation. This report covers Year 1 achievements for the project, *Groundnut varieties improvement for yield and adaptation, human health and nutrition*. The overall goal of the project is the reduction of poverty by improving income levels, enhancing food and nutrition security through investments to improve groundnut yields, mitigating the effects of aflatoxin contamination and its effects on human health for the groundnut farming communities of Malawi and Tanzania. The two countries have approximately 2.8 million farm families who will benefit directly from adopting improved groundnut technologies. Project strategy involves diagnostic studies, breeding and capacity building to address low yields, diseases (rosette, ELS, and rust), aflatoxin contamination and drought. Project impact will contribute to improvement of rural livelihoods, better human health, nutrition and increased incomes from trade.

The project will deliver four main outputs: a) High yielding farmer and market-acceptable groundnut varieties with resistance to foliar/viral diseases and aflatoxin contamination developed; b) Nutritional status, dietary diversity, human health and mycotoxin contamination problem spatially characterized; c) Adoption rates of improved farmer and market-acceptable varieties and production technologies enhanced; and d) Adoption rates of improved farmer and market-acceptable varieties and production technologies enhanced.

Highlights of the progress made by the Project during the reporting period (September 2010 – August 2011) are provided below:

- Two hundred forty five (245) crosses introgressing new sources of aflatoxin, rust and Groundnut Rosette Disease (GRD) resistance were produced during the 2010/11 season.
- F1 from these crosses are being advanced and a Backcrosses (BC1F1) nursery has also been established.
- Segregating progenies from the first phase has yielded 2898 lines for rust (F6), 1614 lines for Early Late Leaf Spot (F6), and 900 lines for GRD populations (F5), which continue to be advanced.
- Nuclear seed of two hundred fifty five (255) lines in advanced testing in quantities ranging from 2 to 10 kg was produced in Malawi, while Tanzania produced seed of six varieties in quantities ranging from 20 to 320 kg.
- Fifteen thousand six hundred and forty one (15,641) kg of breeder seed for ICGV-SM 90704, ICG 12991, CG 7, JL 24, Nyanda, Pendo and MGV 5 was produced in Malawi and Tanzania during the 2010/11 season.
- Eighty (80) sets of trials and breeding nurseries consisting of 4 to 582 lines were distributed to various National Programs throughout Eastern and Southern Africa.

- Thirty seven (37) demonstrations of farmer friendly options for the management of aflatoxin and GRD were successfully established in farmers' fields in Malawi.
- A survey to establish the extent of aflatoxin contamination in groundnuts and maize in Tanzania has been completed and results are being compiled.
- In collaboration with Sokoine University of Agriculture, nutrition studies have been initiated in Tanzania in two target districts (Chamwino and Bahi).
- In collaboration with Kamuzu Central Hospital in Malawi, eight sensitization workshops were organized in Mchinji and Salima to share with farmers the results of the aflatoxin survey project and follow-up plans to establish the problem in humans. As a result 126 villagers voluntarily donated blood for testing.
- On Participatory Variety Selection (PVS), thirty (30) mother trials and forty two (42) baby trials were established by fifteen farmer groups (each group with 15 farmers) in Malawi.
- Two (2) field days (Malawi) and 1 field day (Tanzania) were conducted, engaging various stakeholders to elicit views on varieties and other technologies under on farm trials.
- Twenty (20) new community seed banks have been established in Mchinji, Malawi.
- Training on aflatoxin analysis in blood samples was facilitated in which two (2) staff from Kamuzu Central Hospital and ICRISAT Malawi working directly with the project underwent training at ICRISAT Headquarters in India.

In the Research Report section, activities undertaken during the reporting period between September 2010 and August 2011 have been compiled by objective. For each, a brief introduction is followed by a narrative summary of activities undertaken preceding short comments on implications of the research findings for the next stage of research, for suggested development activities, and for policy where applicable.

Objective 1: High yielding farmer and market-acceptable groundnut varieties with resistance to foliar/viral diseases and aflatoxin contamination developed

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Introduction

Smallholder farmers in sub-Saharan Africa (SSA) including Malawi and Tanzania strive hard to attain their nutritional well-being from the meager harvests of their main staples. Staple diets in this region are usually based on cereals (maize, sorghums, and millets) and legumes (groundnut, beans, pigeonpea) with significant dependence on root crops, particularly cassava and sweet potato. Groundnut (*Arachis hypogaea* L.) is rich in digestible protein (25-34%), oil (44-56%), amino acids, and vitamins. It is an important food and cash crop and a major source of dietary oil and cash income for both urban and subsistence dwellers. But groundnut yields are severely constrained by fungal foliar and viral diseases. In addition to maize, cassava and other commodities, groundnuts also have been found to accumulate aflatoxins which are known to suppress the human immuno-response system. This can have harmful effects on HIV and AIDS-infected members of the community because groundnut is consumed widely. Through past research ICRISAT has identified germplasm with resistance to drought and diseases, with special focus on resistance to *Aspergillus spp*. While screening continues, the few identified germplasm are already being used for resistance introgression into farmer/market preferred varieties.

Narrative Summary

The following activities were undertaken in the two countries during the reporting period, September 2010 to August 2011.

1.3. Identify germplasm and introgress traits for yield components, farmer/market preferences, and adaptation to biotic and abiotic (drought) resistance/tolerance;
1.4. Develop diverse groundnut breeding lines and populations while developing capacity to screen for GRD and foliar disease resistance;
1.5. Develop advanced breeding lines and varieties of groundnut with special emphasis on resistance to aflatoxin contamination.

Progress of Outputs

1.1. Identify germplasm and introgress traits for yield components, farmer/market preferences, and adaptation to biotic and abiotic (drought) resistance/tolerance

1.1.1. Additional sources of resistance to foliar diseases and aflatoxin identified from core collection, local germplasm and wild germplasm

Materials resulting from crosses (good x good crosses) introgressing resistance into farmer and market preferred varieties were developed in the first phase of the project. Introgressing GRD, rust, early and Late Leafspot into farmer/market preferred varieties are currently in F1 – F4 generation advance at Kasinthula Research Station in Malawi.

Additionally, and as a result of screening activities and grafting experiments during Phase I, a number of materials with good resistance to Groundnut Rosette Disease (GRD), Rust and Aflatoxin were identified and their resistance confirmed. These materials have formed a basis for new hybridization activities in Phase II. For GRD, resistant lines included: ICG 14705, ICG 13099, ICG 9449 and ICG 15405; for Rust: ICGV 02194, ICG 11426, ICGV 01276 and ICGV 02286; and for aflatoxin: J11, Ah 7223, ICGV-SM 02538, ICGV 92280 and ICGV 95494.

Following this achievement, a nursery having two hundred and forty five (245) crosses was established in September 2010 at the Chitedze Research Station's ICRISAT hybridization block in Malawi with the objective of introgressing GRD, rust and aflatoxin resistance into farmer/market preferred varieties including varieties currently released in Tanzania and a number of improved varieties in Malawi. Targeted varieties for improvement include Pendo, ICGV-SM 01721, ICGV-SM 01711, ICGV-SM 99555 and ICGV-SM 99557 for Tanzania; Chalimbana, CG7 and JL 24 for Malawi; and ICGV-SM 01514 and ICGV-SM 05701 for Mozambique. F1 materials from these crosses are currently being advanced at Kasinthula Research Station to expedite results and make available materials for wider utilization in the region. A backcross nursery for these F1 materials (BC1F1) has also been established at Chitedze Research Station in ICRISAT glasshouses using these target and adapted varieties as recurrent parents.

With additional support from the TL 2 project, segregating progenies for three (3) major biotic constraints currently in F6 are available for exploitation and also going through generation advance. This effort has yielded a total of 2898 lines comprising five (5) populations for Rust (F6), 1614 lines consisting of four (4) populations for Early Leaf Spot (F6), and 900 lines comprising four (4) populations for Groundnut Rosette Disease (GRD) at F5 generation.

1.2. Develop diverse groundnut breeding lines and populations while developing capacity to screen for GRD and foliar disease resistance in Tanzania

The project continues with efforts to gain more sources of resistance to both biotic and abiotic constraints and build up on successes made in Phase I. Disease screening activities in Tanzania focused on 3 trials with 61 groundnut varieties from ICRISAT tested under the Groundnut Regional Trials series. Trials consisted of 25 varieties for Elite Rust Resistance variety trial, 16 for Regional Rust Resistance variety trial, and 20 for Regional Drought Resistance variety trial. A nursery has 286 lines from the groundnut reference set and two hundred ten (210) rust and late leaf spots segregating populations in the F4 generation.

The project, through the Naliendele Agriculture Research Institute, also collected 12 local varieties from farmers in the main groundnut growing areas of Masasi and Dodoma, Morogoro, Singida and Shinyanga. This local germplasm was multiplied for maintenance and provision of seed for experimental purposes.

Results from the screening activity showed significant differences p=0.05, between varieties for both pod yield and rust resistance. Varieties by site interactions were also observed. Higher rust scores were observed at Hombolo compared to Naliendele and Nachingwea. Overall, CG 7, ICGV-SMs 05570, 06711 had the highest pod yield under the Regional Rust Resistance variety trial (Appendix 1a) while ICGV-SMs 08573, 08586, and 08582 gave the highest pod yield (>1600kg/ha) under the Elite Rust Resistance variety trial (Appendix 2). At Naliendele the main research location for oilseed crops, the best varieties in the study were ICGV-SM 08588, ICGV-SM 08587, ICGV-SM 08582, ICGV-SM 94114 and ICGV-SM 08573 all giving a pod yield of >3000kg/ha for Elite rust resistant groundnuts variety trial. Varieties ICGV 94114, CG 7, ICGV-SM 05570, ICGV-SM 90092, ICGV-SM 07570 and ICGV-SM 06711 had high pod yield at Naliendele for regional rust resistant groundnuts variety trial (Appendix 1a). Varieties CG 7, ICGV 90082, ICGV-SM 05616, 86-87/175 (b) and ICGV-SM 06711 had high pod yield at Nachingwea for regional rust resistant groundnuts variety trial. At Hombolo where high rust scores were observed, ICGV-SM 05569 was the most resistant line with a rust score of 1 on a scale of 1-9. High yields observed at Naliendele are likely due to relatively higher rainfall (1112.6mm) compared to 739.2 for Nachingwea (Appendix 15). The very good yields observed at Naliendele relative to the other stations is also due to the fact that rock phosphate equivalent to 80kg/ha P2O5 was supplied.

In Malawi, a number of nurseries ranging from preliminary to regional trials were screened under different environments: twelve (12) for Early Leaf spot high disease pressure and fourteen (14) under rosette high disease pressure – both at Chitedze Research Station; seven (7) under rust and Late Leafspot at Chitala Research Station; and seven (7) under drought stress at Ngabu Research Station. For ELS, GRD and Rust, high disease pressure was obtained through use of the infector row technique and repeated aphid seeding in the case of GRD.

The Regional Rust Groundnut Variety Trial was evaluated at Chitala and Ngabu for pod yield and rust (Appendix 1b). Low yields were generally experienced in the two environments but offered excellent conditions for rust and drought screening. ICGV-SM 05611 showed good yield promise both at Chitala (1194.4kg/ha) and Ngabu (802kg/ha) out-performing the check ICGV-SM 90704. In Ngabu, 86-87/175 (b), ICGV-SM 05569, and ICGV-SM 06735 were the most resistant varieties with a rust score of 1-1.5, on a 1-9 disease rating scale compared to a score of 6 for the check ICGV-SM 90704. ICGV-SM 05569 and ICGV-SM 05611 seemed to combine both yielding and disease resistance ability (827.8kg/ha to 1194 kg/ha and rust score of 1 and 2.5 respectively). The Regional Drought Resistance Variety Trial was only tested at Ngabu (Appendix 1c). Significant differences p=0.05, in pod yield, kernel yield and 100 seed weight (measure of seed size) were observed. ICGV-SM 03520 and ICG 14788 were the best varieties giving yields of 1058.2 kg/ha and 1062kg/ha respectively compared to 872.5kg/ha for the check JL 24. ICG 14788 had the largest seed in the trial and significantly better than JL 24 (45 g/100 seed mass vs. 31g/100 seed mass) .

1.2.1. Germplasm exchange between Malawi, Tanzania, Mozambique and others partners

a) Nuclear seed of elite lines produced annually for testing and breeder seed production

- Nuclear seed of 255 lines under advanced testing in the National Programs in Eastern and Southern Africa were produced in quantities ranging from 2-10 kg by ICRISAT at Chitedze Research Station. This includes varieties recently released in Tanzania and Mozambique. This effort will ensure continued support to NARS and other partners for their respective breeding programs and/or further testing for agronomic pursuits. In Tanzania, nuclear seed for varieties Mnanje, Mangaka, Masasi, Nachingwea, Nyota and Johari were produced in quantities ranging from 20-320 kg.

b) Breeder seed of improved groundnut varieties available to NARS and NGOs in ESA region on an annual basis

- Various quantities of breeder seed were produced in Malawi and Tanzania in this reporting period. In Malawi, 6892.45 kg of GRD resistant variety ICGV-SM 90704, 667 kg of Aphid resistant ICG 12991, 1953.35 kg of high yielding CG 7, 3285 kg of early maturing JL 24, 1006.85 kg of early maturing Nyanda and 275.45 kg of MGV 5 were produced. The project in Tanzania also produced 2,640 kg breeder seed of the farmer and market preferred variety, Pendo.

Table 1 (below) shows groundnut trials and nurseries by category distributed to National programs in the reporting period in the sub region. A total of 80 sets comprising of lines ranging from 4 to 582 were distributed.

Table 1. Distribution of germplasm to National Programs - 2010/11 season

Nursery	Malawi	Tanzania	Mozambique	Uganda	Total no. of sets
International Trial sets	6	7	7	8	28
Advanced Breeding Lines (sets)	26	2	18		46
Early generation breeding material/population (sets)		2			2
Germplasm samples		3			3
Others (varieties, breeder seed)		1			1
	32	15	25	8	80

1.3. Develop advanced breeding lines and varieties of groundnut with special emphasis on resistance to aflatoxin contamination

In search of resistance to aflatoxin contamination, a potted experiment involving two (2) sets each with 24 promising lines + a susceptible check (JL 24) was set up in March 2011 at the Chitedze Research Station. The experiment arranged in a Randomized Complete Block Design was exposed to two treatments under controlled environment: irrigation and water stress, each replicated twice. This is premised on the fact that pre-harvest groundnut contamination is chiefly enhanced by end season drought. Dry pod zone during pre-harvest period results in cracks on the pod providing entry for the fungus which is the main source of contamination. As the fungus enters the kernel, it will be able to establish itself and produce aflatoxin in susceptible genotypes.

This screening method will help identify elite materials that could be recommended for release or used in the crossing program for introgressing of aflatoxin resistance into locally adapted and or farmer/market preferred varieties. The trial has been harvested but data processing for reporting purposes has not yet been completed.

Responding to the need for more groundnut varieties with high yield potential and other desirable attributes such as resistance to insect pest and diseases of major economic importance in groundnut production, trials for three botanical groups, Spanish, Virginia and Valencia were conducted at Naliendele, Nachingwea, Makutopora, Bihawana and Hombolo in Tanzania and Chitala and Ngabu for Malawi. These consisted of 16 entries of Elite Spanish materials, 20 Virginia, and 20 Valencia varieties. Trials were laid out in 4x4 and 5x4 lattice designs with 2 replications. The plot size was 4 rows each, 4 meters long, spaced 75 cm apart and 10-15 cm between plants within a row, with wider spacing for the Virginia materials. Data collected included initial plant stand, final plant stand, days to 75% flowering, pod yield, kernel yield, haulm yield, shelling percentage, 100 seed weight, ELS score, LLS score and Rust score.

All three botanical groups of groundnuts (Spanish, Virginia and Valencia) were evaluated in Tanzania. Results showed significant differences among the Spanish types for pod yield p=0.05 (Appendix 2b). Significance differences in pod yield p=0.05 among Virginia varieties were also observed (Appendix 2c). However, no significant differences, p=0.05, amongst varieties were observed for the Valencia types (Appendix 3a). ICGV-SMs 01514 (2014 kg/ha) and 03516 (2079kg/ha) were the best yielding under the Spanish varieties, ICGV-SMs 05558 (2088kg/ha) and 01711 (1963kg/ha) were the best under the Virginia types, while for Valencia ICGV-SMs 07520 (1562kg/ha) and 07518 (1621kg/ha) gave the highest pod yields.

For Malawi, significant differences, p=0.05, were observed in pod yield, kernel yield and Early leaf spot resistance at Ngabu. ICGV-SM 01514 was the highest yielding genotype with pod and kernel yields of 1646kg/ha and 1035.7kg/ha, respectively (Appendix 3b). ICGV-SM 00537 seemed to combine high yield and disease resistance, 1537kg/ha for pod yield and an ELS score of 3, on a 1-9 rating scale. No significant differences, p=0.05, in pod yield, kernel yield and rust score were observed at Chitala. However ICGV-SM 03516 was the highest yielding genotype at this site. No genotype was superior to the check JL 24.

For Valencia, best yielding varieties included ICGV-SMs O7557 and 07553 though not significantly better than the check (JL 24) for yield at Ngabu (Appendix 3c). The highest yielding genotype at Chitala was ICGV-SM 07520 with yields of 1250kg/ha and 727kg/ha for pod and kernel yield respectively.

Implication of research findings

Identification of aflatoxin resistant varieties will be an important finding for the region as currently there is no released variety known to offer such resistance. Aflatoxin resistance introgression into varieties already encompassing farmer/market preferences will be the key to safeguarding consumer safety, improving nutrition and assuring higher incomes from marketable produce. Ultimately we would like to be able, through this project, to identify the signal controlling host/pathogen interaction leading to the establishment of pathogenicity and production of aflatoxin in susceptible genotypes with a view to the development of resistant varieties. The MSc planned for aflatoxin work in this project will enable us to link with the University of Georgia in collaboration with the National Peanut Research Laboratory for this effort and initial contacts have already been developed.

Objective 2: Nutritional status, dietary diversity, human health and mycotoxin contamination problem spatially characterized

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Introduction

Aflatoxin, produced by the fungi *Aspergillus flavus* / *A. parasiticus,* has been reported to retard growth and productivity in both humans and animals. It has also been linked to diseases like Hepatic Cellular Carcinoma, as well as exacerbating the ill effects of HIV and AIDS. Exposure to aflatoxins resulting from consumption of contaminated foods can aggravate the already delicate condition in smallholder populations, such as those in many areas of Malawi and Tanzania, who are food insecure and subsist on poorly produced and poorly stored legume and cereal-based diets. The main strategy in this objective is generation of information that will inform policy and feed into relevant national initiatives that target food safety in the two countries for development of appropriate standards and/or regulatory frame works.

The following are the major activities implemented under this objective during this reporting period:

2.1. Assess aflatoxin load in exposed populations and relationships to health-related ailments;
2.2. Assess aflatoxin load in exposed populations and relationships to nutrition as determined by body mass index (BMI).

Progress of Outputs

2.1. Assess aflatoxin load in exposed populations and relationships to health-related ailments

Based on the outcomes of the aflatoxin survey conducted in Malawi, the Project Team from Kamuzu Central Hospital selected two districts of Mchinji and Salima for this reporting period. Salima was amongst the few drought prone districts which had high levels of aflatoxin contamination, while Mchinji is one of the major groundnut producing districts in Malawi with significant consumption and therefore high potential for contamination. Participants in this activity included both vulnerable and non-vulnerable groups. The team embarked on a sensitization campaign with the assistance of medical officers working in the selected communities to outline the scope and objectives of the study.

The project managed to procure all the required medical equipment for blood sampling. The activity which is ongoing commenced in July 2011. In Mchinji, ninety six (96) blood samples were collected from three communities, Kalulu (17), Chiosya (36) and Mkanda (43); while forty six (46) samples were collected from Salima, forty four (44) from the District Hospital and two (2) from Makoni Village. The collected samples are currently at Kamuzu Central Hospital and once the collection is complete, analyses for aflatoxin loads will commence.

The team also plans to start umbilical sample collection and biopsy procedures in November 2011.

2.2. Assess aflatoxin load in exposed populations and relationships to nutrition as determined by body mass index (BMI)

The project through Sokoine University of Agriculture (SUA) conducted a number of preliminary activities in Tanzania including a baseline survey to identify the existing complementary foods, their preparation methods, and to assess childcare and feeding determinants. An inception meeting with ward extension officers and village officials in two selected villages was conducted from 2-4 October 2010. The SUA project team met the ward extension officers and village officials in Mundemu (Bahi district) and Muungano (Chamwino district) to discuss the scope and objectives of the project. The SUA team in collaboration with the ward extension officers and village officials then identified 40 women involved in groundnut farming with children aged between 6-12 months from the two villages. Willingness to participate in the project was another key factor considered in the selection criteria. These mothers were chosen randomly from each village. The second activity conducted from 10-11 May 2011 was to sensitize the identified mothers through open meetings on the importance of good nutrition, good hygiene practices and improved childcare.

To identify the existing complementary foods and their preparation methods and assess child care and feeding determinants, a baseline survey was conducted in the two villages using a structured questionnaire consisting of open- and close-ended questions. The questionnaires were administered to the 40 selected women. Additionally focus group discussions with key informants were conducted. The activity was conducted from 7-10 August 2011.

Results of the survey showed maize and sorghum as being the major cereals grown in Muungano while millet was the major cereal in Mundemu. The production trend in Muungano, however, did not tally with usage as most mothers use sorghum (90%), 85% use pearl millet, and only 50% use maize for preparing complementary foods. In the case of Mundemu village, about 80% of mothers use millet and pearl millet for complementary foods preparation. It was also shown that most mothers (80%) in Muungano and Mundemu villages start giving complementary foods at the age of six months compared to 20% that start giving complementary foods to their children at the age of three and four months (Figure 1). Most of the respondents cited instructions from their clinic which stipulate six months as the right age for starting complementary feeding as the reason for this outcome. Additionally, almost all mothers give their children stiff porridge as complementary food. About 60% give them plain cereal porridge and a very few (30%) use cereals mixed with groundnuts as complementary food, as well as soft rice.

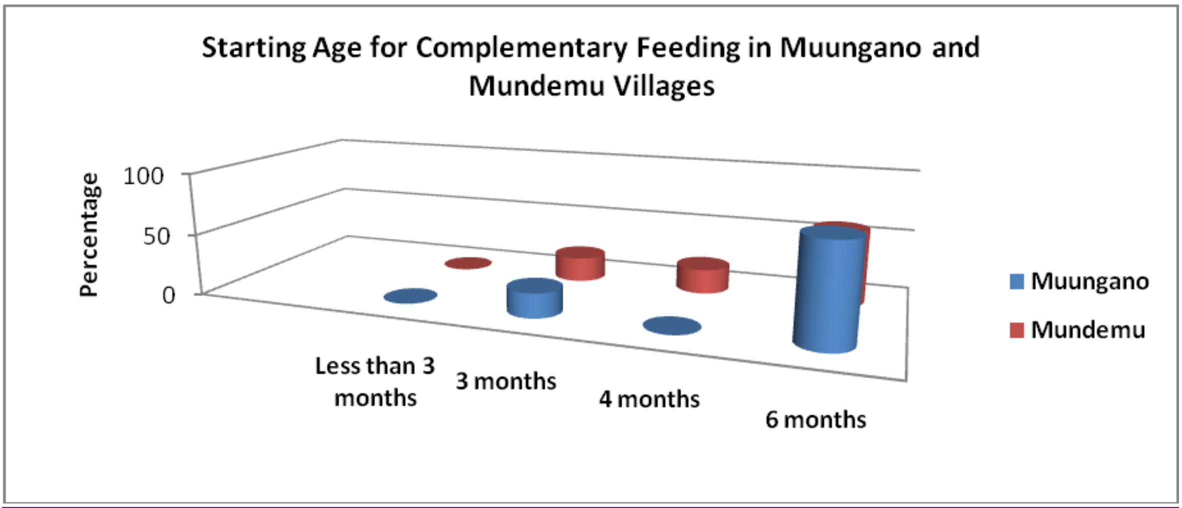

Figure 1. Starting age for complementary feeding in Muungano and Mundemu villages

Results also show that a few mothers – 20% in Muungano village and 38% in Mundemu – use groundnut for complementary foods and this usage does not follow specific proportions but is simply based on availability of the product. Only a few respondents were aware of groundnut as a source of protein and did not use it for nutritional purposes.

On childcare, the survey showed that the majority of mothers (80%) in both districts stop breast feeding their children when they are 24 months old, a few mothers stop breast feeding below the age of 18 months, and about 10% feed them until the age of 30 months (Figure 2).

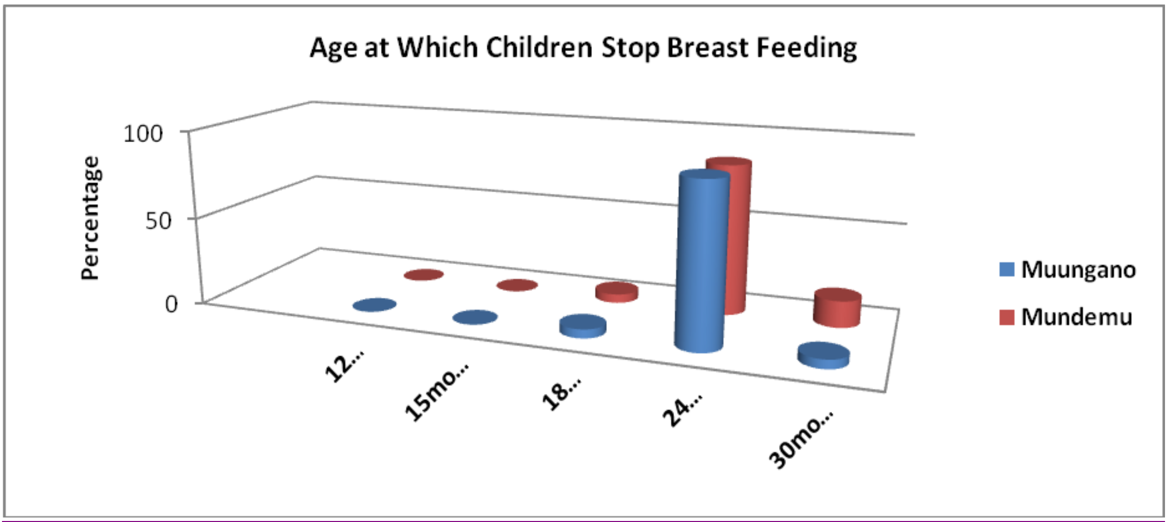

Figure 2. Age at which breast feeding stops in Muungano and Mundemu villages

Implication of research findings

Defining the scale of mycotoxin contamination as well as assessing aflatoxin loads in exposed populations will help in planning an integrated approach for management of aflatoxin contamination in food in sub-Saharan Africa. This will help in formulating appropriate policies for food safety. It will also help in designing appropriate interventions for critical areas including post-harvest handling of commodities. The baseline survey

(Nutrition) data in Tanzania, has revealed basic information from the mothers which will be used to formulate appropriate complementary foods.

For policy

Policy will be impacted through information sharing to facilitate decision making. Policy guidelines and direction will be positively impacted through maintenance of standards, e.g. allowable levels of mycotoxins in food and feed, acceptable nutritional status. This will also strengthen health laboratories and encourage the inclusion of aflatoxin detection capacity.

Objective 3: Adoption rates of improved farmer and market-acceptable varieties and production technologies enhanced

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Introduction

Continued development and strengthening of the already existing platforms and or communication mechanisms is key to an effective and efficient technology dissemination program. This will strengthen the project's islands of success and contribute to meaningful adoption of technologies by farmers. The multi-disciplinary partnership approach used in the first phase has again been employed to deal with this multifaceted problem and so far farmers, community leaders, researchers, extension agents, traders and processors have been engaged in order to achieve wide scale adoption of best practices for pre- and post-harvest management of aflatoxins. Conducting demonstrations of improved technologies on farmers' fields will improve their understanding of the problem (learning-by-doing) and enhance adoption of such technologies and also offer a forum for selecting and promoting preferred varieties and best bet resource management interventions.

Aflatoxins also continue to be a major limitation to groundnut trade in both countries. Thus, any improvement in management of the contamination at farm level would potentially result in increased trade with regional and international partners. Providing better information on the distribution of aflatoxin and underlying factors will support efforts to manage contamination at the farm level.

Narrative Summary

This objective is implemented through research responding to the 4 major activities shown below:

3.1. Conduct participatory adaptive trials to assess mycotoxin management practices relating to crop production in pre- / post-harvest operations, and demonstrations for post-harvest handling, food processing methods, consumption patterns and diets;
3.2. Conduct field days, agricultural shows & rural seed fairs with farmers, researchers and market players to promote improved mycotoxin management, including testing of resistant cultivars;
3.3. Market players to promote improved mycotoxin management practices, including testing of resistant cultivars;
3.4. Enhance institutional innovations to improve access of the poor to good quality seeds of improved high yielding adapted varieties.

Progress of Outputs

3.1. Conduct participatory adaptive trials to assess mycotoxin management practices relating to crop production in pre- / post-harvest operations, and demonstrations for post-harvest handling, food processing methods, consumption patterns and diets

a) Investigation of technologies for the reduction of aflatoxin contamination (on-station trials) in Tanzania and Malawi

In order to develop more farmer friendly management options for mitigating pre-harvest aflatoxin contamination in Malawi, an on-station trial was established on 25 January 2011. The objective underlying this trial is to compare a new set of improved methods with farmers' conventional practices, and it is set to run for at least two years and outcomes will help design an appropriate combination of treatments for on-farm testing. Currently, the trial arranged in factorial design has three (3) factors: varieties with two levels (resistant J11 and susceptible ICGV-SM 99568), water management at two levels (tied ridges vs. open ridges) and soil amendment factors at three levels (manure 0 kg/ha vs. 1.75 t/ha, lime, 0 kg/ha vs. 200kg/ha, and phosphorous, 0 kg/ha vs. 400kg/ha Single Super Phosphate). Varieties were the main plot factors, water management being sub-plot, and soil amendment factors the sub-sub plot, with each of the sub-sub plot factors operating at two (2) levels. Farmyard manure supplying 1.28% N, 2.29% K, 0.48% P was used. Additionally Single Super Phosphate (SSP) supplying 80kg/ha of P (20% P2O5) was also used. Factors were deliberately chosen, all being critical to minimizing exposure of groundnuts to fungal infection. Data collected included plant stands, pod weight and soil samples. A 100g sample for groundnuts was then subjected to aflatoxin analysis using Enzyme Linked Immuno Sorbent Assay (ELISA).

Results for aflatoxin contamination (Afb1) show significant differences, p=0.05, for varieties. J 11 (resistant variety) gave a lower level of aflatoxin contamination (321.2ppb) compared to ICGV-SM 99568 (susceptible variety) which recorded 1110.9ppb. Even though no significant differences, p=0.05, were observed for water management and soil amendment treatments, lower levels of aflatoxin contamination were observed for tied ridges (650.9ppb) compared to 781.2 ppb for open ridges. Lower contaminations were also observed through use of lime (743ppb vs. 805.9ppb for no lime), manure (426ppb vs. 837 for no manure) and phosphate fertilizer (614.7ppb vs. 869.5ppb for no phosphate). Results also show no significant differences in aflatoxin contamination for variety, water management and soil amendment interaction, lower levels however, were observed for all varieties with tied ridges and where soil amendment factors (lime, manure and phosphate) were applied (Appendix 4). Findings have demonstrated considerable reduction in aflatoxin contamination through use of resistant varieties, tied ridges, manure, lime and phosphate fertilizer.

b) Demonstrate technologies for the reduction of GRD on smallholder conditions

The trial aims at popularizing available and common disease management technologies amongst smallholder farmers, validate best cultural practices with specific improved varieties and help small scale farmers improve food security and incomes through reduction of GRD. Three options arranged in a Randomized Complete Block Design included time of planting (early vs. late [3weeks late]); genotype (resistant vs. susceptible) and plant density (high vs. low). Plots contained four (4) rows, each 10m long with ridges spaced at 75cm and 60cm with 30cm and 10 cm between plants for low and high population density respectively. Important data collected included stand count, rosette count, and pod weight.

Rosette incidences were generally low in the 2010-11 growing season across sites in Malawi. Variance components however, show the same trend with more variation between districts than chapters, but at the same time more variation at chapter level than farmer level for all observations (pod yield, kernel yield and rosette incidence). Results for pod and kernel yield and rosette incidence show significant differences, p=0.001, for individual treatments (varieties, time of planting and plant density). Resistant varieties yielded more than susceptible varieties, 835.5kg/ha and 651.1kg/ha respectively and showed lower average rosette incidences (0.59%) compared to 6.82% for susceptible varieties, similarly, high population density and early planting gave superior yield performance over low population density and late planting, 888.32kg/ha versus 598.83kg/ha and 848 versus 639.4kg/ha, and lower rosette incidences of 3.05% versus 4.37% and 2.6% versus 4.81% respectively. There was a negative correlation (-0.34) between kernel yield and rosette incidence showing an increase in the incidence resulting in a decrease in yield. Significant differences were also observed for the two way treatment interactions, p=0.05. Most varieties showed lower levels of rosette incidence at early planting as well as high density compared to late planting and low plant density (Table 2). Additionally resistant varieties showed incidences of <1% at all levels compared to >3.16% for susceptible varieties. For pod and kernel yield no significant differences were observed on genotype-time of planting and genotype-plant population interactions, p=0.05. However, the overall means for genotype-time of planting and plant density interactions for pod and kernel yield showed better performance at early planting and high plant density. Even susceptible varieties had lower rosette incidences when planted early with high density. Similar trend was shown for the interaction (genotype-time of planting and genotype-plant population) for yield and rosette incidence (Appendices 5 and 6). Variations observed between treatments relay very important information to farmers on the extent to which improved technologies can help mitigate incidences of rosette and that considerable yield gains would be realized through use of improved varieties, early planting and high plant population.

Table 2. Effect of genotype – time of planting and genotype plant population interaction on rosette incidence (%)

	Time of planting		Plant population	
	Early (onset of rains)	Late (3 wks late)	High (60cm x 10cm)	Low (75cm x 30cm)
Variety	Incidence (%)	Incidence (%)	Incidence (%)	Incidence (%)
Chalimbana	6.08	11.02	6.52	10.58
Nsinjiro	0.58	0.47	0.45	0.59
Malimba	3.16	7.03	4.89	5.3
Baka	0.59	0.73	0.33	1
Mean		3.71		3.71
Fpr		0.001		0.015
sed		0.974		0.974
CV %		0.65		65

c) Technologies for the reduction of aflatoxin contamination on smallholder conditions

The objective of the trial was to validate and promote options for the management of aflatoxin contamination of groundnuts on farmers' fields. The trial was planted on 21 farmers' fields in the three districts (Mchinji, Nkhotakhota and Mzimba) but the report will focus on the results of 14 trials which were planted at the right time and whose data processing fell within the reporting period. Three options arranged in a Randomized Complete Block Design included: time of planting (early vs. late [3 weeks late]); genotype (resistant, J11 vs. susceptible, ICGV-SM 99568); and water management (box vs. open ridges). Plots contained four (4) rows, each 10m long with ridges spaced at 60 cm, and 10 cm between plants and tied every 2m for box ridged treatments. Important data collected included stand count, soil samples and pod weight. Both groundnuts and soil samples were transported to Chitedze Research Station for further processing. For groundnuts, a 300g sample was subjected to aflatoxin analysis using Enzyme Linked Immuno Sorbent Assay (ELISA).

Effect of variety on time of planting and water management was evaluated on farmers' fields using a resistant variety J 11 and an elite but aflatoxin susceptible variety ICGV-SM 99568. Results from pod yield revealed that early planting was superior to late planting 925kg/ha vs. 596kg/ha for ICGV-SM 99568, and 713kg/ha vs. 566kg/ha for J 11 respectively. The yields are lower than expected because the trials were planted late – a condition which did not offer opportunity for optimum performance of the varieties (Table 3). Variety x time of planting interaction showed no significant differences, p=0.05, overall means though showed higher yield gains from early planting than late planting for both varieties, 925 kg/ha and 713 kg/ha compared to 596 kg/ha and 566 kg/ha for ICGV-SM 99568 and J 11 respectively (Table 3). For variety x water management interaction, higher yields were observed from box ridged treatments than open ridges for both varieties. Similarly the study was able to show that plot water management through use of box ridges is superior to open ridges. ICGV-SM 99568 on box ridged plot yielded 844kg/ha vs. 677kg/ha on open ridges whereas J 11 on box ridges yielded 676kg/ha vs. 603 kg/ha on open ridges. The trial was also able to demonstrate the positive effects of good agronomic practices on aflatoxin contamination of resistant and susceptible varieties (Appendix 7). Though differences were not significant, lower levels of contamination were observed at early planting 252.9 ppb vs. 324.7 for ICGV-SM 99568 compared to 156.3ppb vs. 349.7ppb for J 11. Similarly, lower levels of contamination were observed in treatments where plot water management was practiced (box ridging) vs. open ridges for both varieties: 210.1ppb vs. 474.5 for ICGV-SM 99568 compared to 230.5ppb vs. 271.9ppb for J 11 Even though there were no significant differences between treatments, variations observed provide evidence of a positive trend. We believe if the trials were planted to utilize the optimum seasonal variation, the results would have been more revealing.

Table 3. Effect of variety x time of planting and water management on pod yield (kg/ha)

	Time of planting		**Water management**	
Variety	**Early**	**Late (3 weeks late)**	**Box ridges**	**Open ridges**
	kg/ha	kg/ha	kg/ha	kg/ha
ICGV-SM 99568	925	596	844	677
J 11	713	566	676	603
Mean		700		700
Fpr		ns		ns
sed		85.3		91
cv %		45.6		45.6

d) Participatory variety evaluation

Farmers (collaborating and non-collaborating), traders and NGOs continue to be engaged in order to elicit more views on variety selection in all project areas for both Malawi and Tanzania covering the three agro-ecological zones: low, medium, and high altitude groundnut growing regions.

In Malawi, the activity directly involved 342 farmers and was undertaken in Nkhotakota, Mchinji and Mzimba. A total of 30 mother trials were established by 15 groups. Each group consisted of about 20 members. Additionally, 42 baby trials were also established by individual farmers. Two groups of trials which included 6 + 2 (checks) for Spanish varieties and 6 + 2 (checks) for Virginia varieties were conducted. For Virginia trials, varieties include ICGV-SM 01708, ICGV-SM 01731, ICGV-SM 01724, ICGV-SM 99772, ICGV-SM 01728, 92R/704 and the two checks, ICGV-SM 90704 and Chalimbana 2005, while Spanish varieties included ICGV-SMs 01514, 03572, 03576, 99551, 99556, 99567 and the two checks ICGV-SM 99568 and JL 24. Sets were planted in a Randomized Complete Block Design using farmers as replicates. Each trial had 8 plots and each plot contained 4 ridges measuring 6m long, ridges spaced at 60cm with 15cm and 10cm between plants for Virginia and Spanish varieties respectively. At least two weedings were carried out and important data collected for stand count, disease severity, pod weight, number of pods per plant, and farmers' preferences. Farmer-chosen preference criteria included yield, taste, seed size, ease of shelling, disease resistance and maturity duration.

Variety Performance

For Spanish trials (Appendix 8), significant differences, p =0.05 were observed for shelling percentage, number of pods per plant, ELS severity and rosette incidence. No significant differences were observed for pod and kernel yield. All genotypes under observation out yielded JL 24 (susceptible check) in kernel yield. Even though JL 24 showed high pod yield, the shelling percentage (60.25%) was poor and below that of overall site mean (69.9%). ICGV-SMs 03576, 03572, 99556 and 01514 gave the highest kernel yields, 1148kg/ha, 1057kg/ha, 1046kg/ha and 1039kg/ha respectively all above the overall site mean (1038kg/ha) (Appendix 8). The four genotypes also showed better resistances to ELS (<3.62) and rosette (<0.83) than the susceptible check (JL 24), 4.68 and 3.2% for ELS and rosette incidence respectively

For Virginia trials, results showed significant differences, p=0.05, in all the traits under observation (pod and kernel yield, shelling percentage, number of pods per plant, early leaf spot severity and rosette incidence). ICGV-SMs 99772 and 01724 out yielded the two checks for pod and kernel yield giving 1296, 931kg/ha and 1523 and 837kg/ha respectively, compared to 1138 kg/ha and 807kg/ha for ICGV-SM 90704 and 1053 kg/ha and 695kg/ha for Chalimbana 2005. These genotypes also performed better than the site means for most of the traits except for number of pods per plant. Even though disease severity was relatively low for Virginia varieties, the two genotypes had ELS score <1.8 and rosette incidence <0.17% compared to 2.26 and 4.92% for ELS and rosette incidence respectively for Chalimbana 2005 (susceptible check) (Appendix 9).

Variety ranking in Malawi

ICGV-SM 99772 was the most preferred Virginia genotype alongside ICGV-SM 90704 (check) specifically for its high yielding ability followed by taste, seed size and ease of shelling (Appendix 10). For low altitude zone (Nkhotakota), in addition to yield, the genotype (ICGV-SM 99772) was preferred for earliness of maturity. In spite of poor ranking for Chalimbana 2005, the variety was the most preferred for seed size and ease of shelling. Districts preferences showed ICGV-SMs 99772 (22.88%) and 90704 (20.06%) as the most preferred in Mchinji, and ICGV-SMs 99772 (31.88%) and 01728 (18.84%) were preferred in Nkhotakota while ICGV-SMs 90704 (25.91%) and 01724 (16.14%) were the most preferred genotypes in Mzimba (Appendix 11).

ICGV-SMs 99551 (taste, seed size and ease of shelling), 01514 (earliness and yield) and 99568 (yield and seed size) were the most preferred Spanish genotypes (Appendix 12). Preferences by district showed ICGV-SMs 99551 and 99556 as the most preferred genotypes in Mchinji and ICGV-SMs 99551 and 99568 as the most preferred genotypes in Nkhotakota while ICGV-SMs 99568 and 99551 being the best for Mzimba (Appendix 13). Variety selection for the Spanish trials showed that seed size, taste and earliness of maturity are the other most important traits in addition to yielding ability. Figure 3 (see Appendix D) shows a farmer displaying one of the highly preferred Virginia type varieties (ICGV-SM 99772).

Variety testing in Tanzania comprised 12 varieties selected from advanced on-station trials at ICRISAT Malawi based on seed yield and other desirable agronomic traits. They were tested on-farm in villages representing groundnut growing areas. The villages included were Nanyumbu, Nahawara, and Nangomba located in Nanyumbu district; Namombwe and

Chikoweti in Masasi district; Naluwale and Luanda in Tunduru district. The trial consisted of 12 plots each with 2 rows measuring 5 meters long with spacing of 0.5m between rows. Farmer selection was based on identified local evaluative criteria.

No significant difference, p=0.05, in variety by site interaction was observed. Overall best performance came from ICGV-SM 01709, ICGV SM 02715 and ICGV-SM 01731 and Mnanje - 2009 with mean pod yield of 1851kg/ha, 1603kg/ha,1486 kg/ha and 1469 kg/ha respectively. The least pod yielding variety was ICGV-SM 90704 and Johari with mean yields of 554 and 583 kg/ha respectively (Appendix 14).

Preference ratings in Tanzania

Farmer preferences showed that ICGV-SMs 02724, 01731 and 01709 (in that order) are most preferred in Nanyumbu, ICGV-SMs 06513, 02724 and 02715 at Nahawara, ICGV-SMs 01731, 02724, and 02715 at Nangomba, while farmers at Namombwe preferred most ICGV SMs 01731, 02715 and 90082 (Appendix 14). At Naluwale the most preferred varieties were ICGV SMs 01731, 02715 and 02724**.** Farmers at Chikoweti most preferred ICGV-SMs 90082, 06513 and 02715**.** The most preferred varieties by farmers at Luanda were Mnanje - 2009, ICGV-SMs 02724 and 01709**.**

Based on farmers' selection, varieties of ICGV-SMs 01731, 02724 and 02715 were selected almost in every village. These findings suggest that ICGV-SMs 01731, 02724 and 02715 should be included in the 2011/12 on-farm trial for further evaluation by farmers.

3.2. Conduct field days, agricultural shows & rural seed fairs with farmers, researchers and market players to promote improved mycotoxin management including testing of resistant cultivars

Field days continue to engage various stakeholders including the private sector in order to increase understanding on issues of mycotoxin management as demonstrated on farmers' fields as well as to present an opportunity to participants to get actively involved in variety selection. They also provide a platform for researchers to provide scientific reasoning to farmers and other stakeholders.

In Malawi two major field days were conducted at Ekwendeni in Mzimba and Katonda in Mchinji on 28 and 31 March 2011 respectively, under the theme *"Improving income, nutrition and health of farmers through improved groundnut technologies including varieties*". The field days attracted a total of seven hundred and ninety seven (797) participants (371 males and 426 females), and included farmers (collaborating and non-collaborating), officials from the Ministry of Agriculture and Food Security, Traders, Bunda College of Agriculture, Traditional Authorities and NGOs. The field day was also covered by M'mudzi Wathu Community Radio Station which eventually produced a program on the same with special focus on groundnut production technologies and aflatoxin awareness.

In Tanzania, one (1) farmer field day (FFD) was conducted at Nahawara village in Nanyumbu from 6 to 7 May 2011. The activity attracted a total of 100 farmers from nearby villages and district authorities also participated. The field day combined video films on groundnut technologies shown on the eve of the FFD and an actual visit to on-farm trial plots. The activity provided opportunity for collaborating farmers to interact with non-collaborating farmers in that village and neighboring villages. Farmers also discussed how best they could increase production of groundnuts and requested district councils to support the acquisition of power tillers as a way of increasing labor productivity.

3.3. Market players to promote improved mycotoxin management including testing of resistant cultivars

The project has engaged the Department of Agriculture and Nutrition at Ekwendeni Hospital to help promote technologies for the management of aflatoxin. The Department works with over nine thousand (9000) farming families and has well established structures in the northern part of Mzimba district with the primary aim of uplifting the livelihood of farmers with limited resources using various enterprises including groundnut farming. Sets of Trials and demonstration for the 2010-11 season from ICRISAT were dispatched to the department for use in its platforms to disseminate information on aflatoxin to both collaborating and non-collaborating farmers. The project also trained promoters for the department leading various sections and working directly with farmers on groundnut best production practices as well as on layout of trials. The venture has been one of the major tools for penetrating communities where NASFAM, our main collaborator has no established structures.

3.4. Enhance institutional innovations to improve access of the poor to good quality seeds of improved high yielding adapted varieties

Community seed banks

Positive strides were made in Phase I of the project in establishing community seed banks and Phase II is building on this success, especially in trying to reach more farmers as well as establishing new ones in new project sites. In Malawi and in Mchinji, ninety (90) community seed banks with membership of 2970 farmers are operative. Twenty additional community seed banks were established in Mikundi, a new project site in Mchinji district and similar efforts are underway in Mzimba district. Most farmers under this program have more than an acre each of groundnut of the improved variety Nsinjiro (ICGV-SM 90704). Results of a survey conducted under the Innovative Communication Media and Methods (ICMM) activity from 28 -30 April 2011, showed that many non-member farmers had also acquired seed from collaborating farmers. Farmers mentioned reduction of nutritional diseases amongst their children, ability to meet hospital bills, school fees and other domestic needs and acquisition of basic assets as some of the major improvements groundnut had brought into their lives. These farmers are now able to contribute about 12 tons of certified seed to the ICRISAT seed revolving account annually.

In Tanzania a total of 50 FRG/FFS were involved in seed multiplication in this reporting period. In southern Tanzania (Masasi, Nanyumbu, Tunduru Newala, Tandahimba and Mtwara) 40 groups were involved and 10 from central Tanzania in the districts of Dodoma, Bahi, Kondoa and Kongwa. Forty (40) tons of groundnuts seeds (in pods) were produced in southern Tanzania.

Farmer exchange visit

In Mchinji (Malawi), the project team identified Katonda community as having outstanding groundnut seed production fields. A farmer exchange visit was organized for farmers from the neighboring chapters to appreciate the benefits arising from using the right seed production practices, and to interact and share ideas with fellow farmers. Farmers from Mikundi (new project site) and Chitunda participated in the activity which took place on 2 February 2011. Visiting farmers expressed satisfaction with the manner in which the fields were managed and promised to emulate it so as to realize the full benefits of groundnut farming. Figure 4 (Appendix D) shows farmers visiting the crop during the exchange visit.

Implication of research findings

These on-farm activities were able to validate and demonstrate the effectiveness of improved practices in the management of aflatoxin contamination and GRD disease. For GRD results showed high yield gains through use of resistant varieties, early planting and optimum plant population. Additionally the use of box ridges, early planting, and a resistant line showed good potential for minimizing aflatoxin contamination. Community seed production has had a good effect on the livelihood of farmers; therefore the project will continue to build on these successes by strengthening the existing groups and establishing new ones, especially in the new project sites.

Objective 4: Capacity of partners for management of mycotoxins in food, variety development and enabling policy environment enhanced.

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Introduction
Engaging various stakeholders at every level of the project's activities will enhance information flow and knowledge on critical issues of mycotoxin eradication; it will also instill the collective approach in mitigating this problem. This is an essential component of the project as it will ensure policy is informed about the problem and results in the formulation of an appropriate regulatory framework for products, especially those for the local markets. Increased knowledge will also help partners to carry out future projects in a more focused approach as well as put into place techniques that appropriately harmonize conventional breeding and farmer participatory approaches. Training offered to farmers on the use of best practice technologies for managing aflatoxin will improve adoption of these practices and this will stay in the communities and have a multiplicative effect much beyond the project period.

Narrative Summary

This objective involves five major activities as described below:

4.1. Stakeholders project start-up/ planning workshop to agree on project components for promotion, pilot areas and mode of operation
4.2. Conduct training workshops for NARES staff
4.3. Degree training program to MSc students to develop regional capacity for pathology work including screening of commodities for aflatoxin contamination
4.4. Conduct sensitization workshop for policy makers, NARES/ NGO/ private sector
- 4.4.1. Through a national level workshop, recommended policy options will be advocated to decision-makers at the national level by end of project. Preliminary findings will be shared with stakeholders.
- 4.4.2. Linkages with health and other sectors will be developed and maintained for future collaboration
- 4.4.3. Develop and share project reports, policy briefs and journal articles

4.5. Establish strategy and time frame for impact monitoring and reporting

4.1. Stakeholders project start-up/ planning workshop to agree on project components for promotion, pilot areas and mode of operation

A planning workshop involving project partners was held at Club Makokola in Mangochi in Malawi from 2 to 4 October 2010 for team members to look at lessons learnt in Phase I and use them as a launch pad for Phase II by refining research questions and methods as well as reviewing experimental protocols. Protocols for groundnut breeding for Malawi and Tanzania, Nutrition component by Sokoine University, and the Health component from Kamuzu Central Hospital were presented, reviewed, and refined for implementation. The meeting drew participants from ICRISAT Malawi, NARI, Kamuzu Central Hospital, NASFAM, Sokoine University and NARS Malawi.

4.2. Training workshops for NARES staff

Three (3) project staff from Naliendele Agricultural Research Institute received hands-on training on how to conduct aflatoxin disease survey. The survey was then carried out in Mtwara, Dodoma and Shinyanga regions. The training, including the survey, was facilitated by Mr Harry Msere, a scientific officer in social economics from ICRISAT Malawi from 19 May to 4 June 2011.

A total of twelve (12) Government Extension Officers were trained on groundnut production technologies and principles of seed production. These trainings were conducted in Mchinji and Nkhotakota (project sites) in Malawi prior to the field days held between 28 April and 13 May 2011.

4.3. Degree training program to MSc students to develop regional capacity for pathology work including screening of commodities for aflatoxin contamination

The project has identified two (2) candidates, Athanas Minja from Naliendele Agricultural Research Institute Tanzania to pursue MSc training with a major focus on mapping the alleles responsible for groundnut rosette disease resistance. The candidate has been registered at

Sokoine University of Agriculture. The second prospective MSc student (Ethel Chilumpha) is the current ICRISAT Senior Research Technician with expertise in aflatoxin detection from farm and human samples. Arrangements have been made with the University of Georgia and the Peanut Science Research Laboratory at Dawson, Georgia, for her to study the mechanism of infection that involves the signal for fungal infection and aflatoxin production in the groundnut host. If all goes well she will register during the second half of 2012 (June/August registration).

To attend to current project needs especially with regard to detection of aflatoxin loads in the blood of exposed populations, the project facilitated a training workshop for staff from Kamuzu Central Hospital and ICRISAT-Malawi to acquire skills on collection and analysis of blood samples from exposed populations. The three-week workshop took place at ICRISAT Headquarters in India from 24 September to 14 October 2010, and was attended by Ethel Chilumpha, senior research technician (ICRISAT), responsible for aflatoxin analysis for the region and Tiyamike Chilunjika, a medical doctor/surgeon from Kamuzu Central Hospital. This will help draw appropriate inferences on how aflatoxin is related to reported health ailments in Malawi.

4.4. Sensitization workshop for policy makers, NARES/ NGO/private sector

Stakeholders' information meeting

To increase awareness on issues of aflatoxin, a groundnut stakeholders' workshop was organized in both countries. In Tanzania, the information meeting was conducted with traders from Mtwara Market. Participants were able to see fungus (*Aspergillus flavus*) using microscopes from the otherwise clean-looking groundnuts, resulting from poor post-harvest handling of the commodity. Many admitted that they were not aware that the common practices they follow contribute to contamination. The Chairman of the market traders also emphasized the need for them to improve on grading and storage of their groundnuts and thus contribute towards aflatoxin-free products. The meeting facilitated by Dr Nick Nathaniels was held on 17 June 2011, under the project component, Innovative Communication Media and Methods (ICMM).

In Malawi, a similar activity was conducted on 2 August, 2011 at Kamwendo Teachers Development Center hall in Mchinji district and attracted a total of 16 participants: 2 traders, 7 farmer trainers, 4 Association Field Officers, the Chairman for the Board, Director of the NASFAM-Mchinji Association and the Association Business Manager. Three presentations were made on: 1) aflatoxin contamination and mitigation; 2) impact of aflatoxin on health and nutrition; and 3) effect of aflatoxin on farmer incomes and trade. These were followed by group discussions. Participants were given an opportunity to view through the microscope the fungus that produces aflatoxin as well as to prepare slides for the same activity. M'mudzi Wathu Community Radio Station also interviewed representatives of the various groups for a program targeting listeners' clubs in Mchinji. The platform also provided an opportunity for traders and farmers to map an appropriate way forward to reduce aflatoxin contamination in groundnut and act as a conduit to engage other farmers and traders on the need to follow the right practices. Figure 5 (Appendix D) shows stakeholders taking turns to view the fungus (*Aspergillus Flavus*) through a microscope during the information meeting in Malawi.

4.4.1. Develop and share project reports, policy briefs and journal articles

Leaflets, TV and Radio programs

In Tanzania, the project in collaboration with the Zonal Communication Office sensitized stakeholders on production and marketing of improved technologies including improved seeds, management of foliar diseases and aflatoxin, through radio, TV programs, and posters production. This effort resulted in 20 radio programs and 10 TV programs that were produced and broadcast by the Tanzania Broadcasting Corporation (TBC) nationally. Following this, the demand for seed and technologies has increased tremendously. The Agricultural Seed Agency is producing certified seeds of groundnut in collaboration with Naliendele using Farmer research Groups and NGOs, such as Dutch Connection and Rural Oriented Service Development Organization (ROSDO), Diocese of Tunduru-Masasi Anglican Church, and Diocese of Central Tanzania in Dodoma.

Two (2) posters displaying project achievements and improved seeds were presented during a visit made by the President of the United Republic of Tanzania to ARI Naliendele on 26 July 2011 and later during the Nane nane Agricultural Show in the agricultural show grounds for the Southern zone. The president commended the work done by researchers at Naliendele especially on the development and dissemination of improved seeds. The high point of the National Agricultural Shows in Dodoma happened when three (3) scientists from Naliendele (including the groundnut breeder) received Distinguished Agricultural Research Awards for scientific excellence and contribution to agricultural research and development in Tanzania.

In Malawi, 1500 flyers depicting research highlights from PVS, and Options for the management of rosette and aflatoxin were distributed to various stakeholders during farmer field days organized from 28 April to 13 May 2011, in Mchinji, Nkhotakota and Mzimba districts.

4.4.3. Linkages with the health and other sectors will be developed and maintained for future collaboration

At a stakeholders meeting conducted in Lilongwe Malawi, participants observed that problems emanating from aflatoxin exposure are multiple and require a multi-disciplinary approach The project, in addition to NASFAM and NARI, has the Ministry of Health (through Kamuzu Central Hospital in Malawi and Sokoine University of Agriculture in Tanzania) as partners, in order to fully explore and understand the effect of aflatoxin on health and nutrition in exposed populations. According to Dr Madinda from Kamuzu Central Hospital, there are many health complications that hospitals face the causes of which are not clearly understood and it may only be hypothesized that these may be linked to aflatoxin contamination. This sector is thus an important partner in assessing aflatoxin loads in exposed populations and then developing links to health-related ailments. The project has also involved regulatory sectors, such as the Malawi Bureau of Standards, to ensure that all policy is informed on the magnitude of the problem so that appropriate action can be taken.

4.5. Strategy and timeframe for impact monitoring and reporting

In fulfillment of the M&E plan, team members from ICRISAT Malawi, Emmanuel Monyo (breeder) and Harvey Charlie (scientific officer) undertook a one-week visit to Tanzania in order to monitor field activities on the invitation of Dr Omari Mponda. The team also participated in a seed fair organized in Nanyumbu district on 20 November 2010, in which the breeder assured participants of continued commitment to the development of improved and adapted varieties which could respond to the various challenges farmers face.

The project team, comprising staff from ICRISAT and NASFAM, embarked on a two-week monitoring exercise from 31 January to 14 February 2011, to ascertain the correct establishment of on-farm activities and backstopping; they also distributed data collection sheets. The exercise is meant to help collaborating farmers generate meaningful data which is central to increasing technology adoption rates.

The project team held a planning meeting at the onset of the second phase to develop a monitoring and evaluation tool to facilitate appropriate and timely implementation of activities. The team critically looked at the project indicators and developed a timeframe for setting the milestones, methods of data collection, who to collect what data, frequency of reporting and use of information generated by specific activities. The meeting also considered the basic M&E questions to be used as a probing guide so as to help information users to develop the right intervention strategies and use of proper impact assessment tools. The meeting took place on 7 September 2011 at ICRISAT's Malawi Office to go through the plan and complete the project Theory of Change (TOC) with the support of the Regional Impact Monitoring Officer, Ms Carolyne Nombo.

Appendix B. Publications

Monyo ES, Njoroge SM, Coe R, Osiru M, Madinda F, Charlie H, Waliyar F, Thakur RP, Msere H, Chilumpha E, Chilunjika T, **2011**. Occurrence and distribution of aflatoxin contamination in groundnuts (*Arachis hypogaea* L) and population density of *Aspergillus flavus* in Malawi. Submitted to Crop Protection Journal.

Monyo ES, Njoroge S, Madinda F, Chilumpha E, Charlie H, and Msere H. **2011**. Occurrence and distribution of aflatoxin contamination in Malawi. Abstracts: Mycotoxin Reduction (Mycored) Africa Conference. International Society for Mycotoxicology. 4- 6 April. Cape Town International Convention Center. Cape Town South Africa.

Appendix C. Training and outreach

Three (3) project staff from Naliendele Agricultural Research Institute received hands-on training on conducting the aflatoxin disease survey. The survey was then carried out in Mtwara, Dodoma and Shinyanga regions. The training was facilitated by Mr Harry Msere, a scientific officer in social economics from ICRISAT-Malawi, and it was conducted from 19 May to 4 June 2011. In Malawi, a total of twelve (12) Government Extension Officers were trained on groundnut production technologies and principles of seed production. These trainings were conducted in Mchinji and Nkhotakota (project sites) prior to the field days.

The project also trained two (2) promoters for Ekwendeni Hospital, responsible for the Agriculture Department and working directly with farmers on groundnut best production practices as well as layout of trials. All training activities were conducted from 28 April to 13 May 2011.

Appendix D - Photographs and Tables

Figure 3. Farmer showing the highly preferred ICGV-SM 99772 variety

Figure 4. Farmers in an exchange visit program appreciating groundnuts in Katonda - Mchinji District, Malawi

Figure 5. Farmers in Mchinji taking turns to see the A. flavus fungus through a microscope

Appendix 1a. Regional Rust Resistant Groundnuts Variety Trial Summary for pod yield (kg/ha) across sites in Tanzania

VARIETY	*Naliendele*	*Nachingwea*	*Bihawana*	*Hombolo*	*Mean*
86-87/175 (b)	2288	805	690	1100	1221
86-87/175-3	1877	353	295	760	821
CG 7	3559	1235	1350		**2048**
ICGV 06735	1922	508	270	525	806
ICGV 90082	2494	1221	800	675	1298
ICGV 90099	1771	279	616	775	860
ICGV 94114	3775	245	750	540	1328
ICGV 95342	1912	218	450	1100	920
ICGV-SM 05569	2352	291	511	1120	1069
ICGV-SM 0557	3545	445	700	1690	**1595**
ICGV-SM 05611	2557	556	580	1600	1323
ICGV-SM 05616	2129	945	1430	575	1270
ICGV-SM 06711	3087	749	1430	1400	**1667**
ICGV-SM 07570	3120	694	855	805	1369
ICGV-SM 90092	3441	263	245	550	1125
Nsinjiro	2787	691	434	780	1173
MEAN	2664	594	713	933	1226
CV %	13.2	23.2	20.2	19.0	18.0
LSD	747.5	293.6	326	410.0	441.8
P=0.05	**	**	**	*	*

Appendix 1b Regional Rust Resistant Groundnuts Variety Trial across two sites in Malawi

	Chitala			**Ngabu**	
Cultivar name	**Pod yield kg/ha**	**Kernel yield kg/ha**	**Rust score at 105 days**	**Pod yield kg/ha**	**Kernel yield kg/ha**
86-87/175(b)	466.7	288.2	1	216.7	110.7
88-87/175-3	794.4	518.8	4	238.9	121.6
CG 7	566.7	397	5.5	424.4	233.4
ICGV 90082	205.6	117.2	2.5	483.3	272.7
ICGV 90092	377.8	234.9	3	640	384.7
ICGV 90099	966.7	602.4	4.5	337.8	170.1
ICGV 94114	650	469.2	4.5	567.8	330.7
ICGV 95342	444.4	279.7	5	384.4	208.8
ICGV-SM 05569	827.8	538.5	1	846.7	491.1
ICGV-SM 05570	905.6	557.9	2.5	836.7	495.9
ICGV-SM	1194.4	763.9	2.5	802.2	430.7

	Chitala			**Ngabu**	
Cultivar name	**Pod yield kg/ha**	**Kernel yield kg/ha**	**Rust score at 105 days**	**Pod yield kg/ha**	**Kernel yield kg/ha**
05611					
ICGV-SM 05616	1050	704	3	605.6	326.3
ICGV-SM 06711	1033.3	737.7	4.5	294.4	155.1
ICGV-SM 06735	1000	624.7	1.5	594.4	316.3
ICGV-SM 07570	866.7	489.7	3	813.3	514.4
NSINJIRO	805.6	514	6	240	124.3
Mean	765.9	492.9	3.38	520	293
CV	36	36.9	43.2	47	49.2
LSD	604	398.3	3.09	518.9	305.4
P-value	0.091	0.084	0.06	0.151	0.107

Appendix 1c. Performance of Regional Drought resistant varieties trial at Ngabu Research Station, Malawi 2010/2011 season

Cultivar name	*Pod yield kg/ha*	*Kernel yield kg/ha*	*100 g seed weight (g)*
Baka	1209	886.1	28.5
Chitala	759	501.1	40.5
ICG 14788	1540	1062	45
ICG 14814	863	442.1	40
ICG 9427	584	426.2	28
ICGV 00331	1377	998.1	41.5
ICGV-SM 00528	840	440.6	36.5
ICGV-SM 01510	753	445	33
ICGV-SM 03519	1454	872.7	38.5
ICGV-SM 03520	1771	1058.2	37
ICGV-SM 03540	1000	733.6	33
ICGV-SM 03544	592	358.3	35.5
ICGV-SM 05650	607	353.1	33.5
ICGV-SM 05657	723	409.1	34.5
ICGV-SM 05661	1238	712.8	42
ICGV-SM	1062	540.9	41

Cultivar name	*Pod yield kg/ha*	*Kernel yield kg/ha*	*100 g seed weight (g)*
05666			
ICGV-SM 05680	774	478.4	44.5
ICGV-SM 99541	476	320.4	28.5
JL 24	1487	872.5	31
Nyanda	914	631.3	30
Mean	**1001**	**627**	**36.1**
CV	**18**	**21.3**	**12.9**
L.S.D	**376.7**	**278.3**	**9.706**
P-value	**<.001**	**<.001**	**0.017**

Appendix 2a. Elite Rust Resistant Groundnuts Variety Trial pod yield (kg/ha) across sites

Variety	*Naliendele*	*Nachingwea*	*Makutopora*	*Tumbi*	*Mean*
Baka	2444	866	923	1086	1330
Chitala	2476	1201	1274	1454	1601
ICGV-SM 06737	2664	910	1139	331	1261
ICGV-SM 06750	1820	369	436	127	688
ICGV-SM 06766	2352	296	833	285	942
ICGV-SM 06769	1778	342	331	838	822
ICGV-SM 06771	2740	503	729	1615	1397
ICGV-SM 08572	2452	1483	809	1214	1490
ICGV-SM 08573	3297	1734	803	1375	1802
ICGV-SM 08574	1912	966	1614	364	1214
ICGV-SM 08576	2964	903	763	721	1338
ICGV-SM 08577	3230	1359	750	570	1477
ICGV-SM 08578	2446	1448	1599	989	1621
ICGV-SM 08581	3058	1160	1836	286	1585
ICGV-SM 08582	3330	947	1768	820	1716
ICGV-SM 08583	2930	993	1295	225	1361
ICGV-SM 08584	3244	1269	872	1448	1708
ICGV-SM 08586	2853	1321	2580	390	1786
ICGV-SM 08587	3414	1175	1410	109	1527
ICGV-SM 08588	3596	1206	1758	135	1674
ICGV-SM 87157	725	103	1090	618	634
ICGV-SM 94114	3316	830	1051	330	1382
ICGV-SM 95342	1024	309	511	423	567
ICGV-SM 96714	2540	749	683	112	1021
JL 24	2526	941	1400	1461	1582
MEAN	2605	935	1130	693	1341

Variety	*Naliendele*	*Nachingwea*	*Makutopora*	*Tumbi*	*Mean*
CV %	13.4	29.1	33.6	17.6	36
LSD	729.4	561.1	881	283	674
P=0.05	**	**	NS	**	**

Appendix 2b. Regional Spanish Groundnut Variety Trials 2010-11, pod yield (kg/ha) at Naliendele and Nachingwea -Tanzania

VARIETY	NALIENDELE	NACHINGWEA	MEAN
ICGV 94139	2492	1268	1880
ICGV-SM 00537	1820	732	1276
ICGV-SM 01514	2746	1281	2014
ICGV-SM 03513	1694	1312	1503
ICGV-SM 03516	2957	1201	2079
ICGV-SM 03517	2143	1595	1869
ICGV-SM 03520	2154	1096	1625
ICGV-SM 03530	2580	1241	1911
ICGV-SM 03532	1977	941	1459
ICGV-SM 05723	1584	1641	1613
ICGV-SM 05738	1906	1028	1467
ICGV-SM 96566	2099	1500	1800
ICGV-SM 99537	2193	1138	1666
ICGV-SM 99551	1767	1179	1473
ICGV-SM 99568	2323	1602	1963
KAKOMA	2462	1397	1930
MEAN	2181	1260	1721
CV %	14.8	27.6	
LSD	686.5	740	
P=0.05	*	NS	

Appendix 2c. Regional Virginia Groundnut Variety Trials 2010-11, pod yield (kg/ha) at Naliendele and Nachingwea –Tanzania

VARIETY	NALIENDELE	NACHINGWEA	MEAN
CG 7	2837	917	1877
ICGV-SM 01709	2432	1194	1813
ICGV-SM 01711	2939	986	1963
ICGV-SM 02724	1593	1176	1385
ICGV-SM 03590	1921	643	1282
ICGV-SM 03708	2512	217	1365
ICGV-SM 03710	2044	307	1176
ICGV-SM 05558	3057	1119	2088
ICGV-SM 05562	2322	312	1317
ICGV-SM 05593	2654	327	1491
ICGV-SM 05688	1753	247	1000
ICGV-SM 05693	2601	566	1584
ICGV-SM 06718	1054	272	663
ICGV-SM 06722	2546	770	1658
ICGV-SM 06725	2677	273	1475
ICGV-SM 07593	1443	660	1052
ICGV-SM 07596	2658	613	1636
ICGV-SM 07599	1811	1123	1467
ICGV-SM 08503	2547	808	1678
Nsinjiro	2154	585	1370
MEAN	2278	656	1467
CV %	19.3	18.4	
LSD	921.2	253	
P=0.05	**	**	

Appendix 3a. Regional Valencia Groundnut Variety Trials 2010-11, pod yield (kg/ha) across sites in Tanzania

VARIETY	*NALIENDELE*	*NACHINGWEA*	*MAKUTUPORA*	*MEAN*
ICGV-SM 06687	1287	759	1216	1087
ICGV-SM 07501	2218	642	1362	1407
ICGV-SM 07502	1668	844	1925	1479
ICGV-SM 07503	2125	888	1370	1461
ICGV-SM 07504	1549	619	1622	1263
ICGV-SM 07505	1487	614	1334	1145
ICGV-SM 07506	1259	694	1527	1160
ICGV-SM 07509	1200	678	1099	992
ICGV-SM 07510	1497	728	552	926
ICGV-SM 07517	1338	675	1418	1144
ICGV-SM 07518	1839	635	2388	1621
ICGV-SM 07520	1720	520	2446	1562
ICGV-SM 07528	2128	910	935	1324
ICGV-SM 07533	2202	643	1228	1358
ICGV-SM 07550	1392	853	1672	1306
ICGV-SM 07553	1903	675	1524	1367
ICGV-SM 07557	1508	599	1106	1071
ICGV-SM 95741	1755	553	428	912
ICGV-SM 99568	1541	826	2357	1575
JL 24	1646	716	1528	1297
MEAN	1663	704	1452	1273
CV %	21.0	19.5	20.8	
LSD	732.3	286.9	654	
P=0.05	NS	NS	NS	

Appendix 3b. Regional Sapnish Groundnut Variety Trials 2010-11, pod yield (kg/ha) across sites in Malawi

	Ngabu			Chitala		
Cultivar name	**Pod yield kg/ha**	**Kernel yield kg/ha**	**ELS at 100 days**	**Pod yield kg/ha**	**Kernel yield kg/ha**	**Rust score at 90 days**
ICGV 94139	408	203.4	3.5	655.6	342.4	4
ICGV-SM 00537	1537	861.3	3	894.4	540.6	4.5
ICGV-SM 01514	1646	1035.7	4	888.9	433.4	4

	Ngabu			Chitala		
Cultivar name	**Pod yield kg/ha**	**Kernel yield kg/ha**	**ELS at 100 days**	**Pod yield kg/ha**	**Kernel yield kg/ha**	**Rust score at 90 days**
ICGV-SM 03513	702	416.8	3	666.7	396.1	4.5
ICGV-SM 03516	1224	681.1	4.5	1077.8	747.9	4.5
ICGV-SM 03517	1221	623.3	7	1005.6	555.1	4.5
ICGV-SM 03520	1268	737.6	6	716.7	386.1	4.5
ICGV-SM 03530	1538	919.7	6.5	994.4	633.1	4.5
ICGV-SM 03532	1390	890.6	6	777.8	471.8	4
ICGV-SM 05723	1378	924.9	5	638.9	400.9	5
ICGV-SM 05738	542	252.7	2.5	877.8	509.3	4
ICGV-SM 99537	489	279.9	4.5	911.1	420.8	5
ICGV-SM 99551	564	261.5	3	644.4	340.8	5
ICGV-SM 99566	1144	613.4	4.5	972.2	630.9	4.5
ICGV-SM 99568	741	461.7	4.5	1377.8	722.5	4
KAKOMA	1612	967.3	6	1016.7	561.1	5.5
Grand mean	**1088**	**633**	**4.59**	**882**	**506**	**4.5**
CV	**24.1**	**27.7**	**16.8**	**25.2**	**35.5**	**11.1**
L.S.D	**556.1**	**372.3**	**1.633**	**470.6**	**380.2**	**1.06**
P-value	**<.001**	**<.001**	**<.001**	**0.181**	**0.473**	**0.18**

Appendix 3c. Regional Valencia Groundnut Variety Trials 2010-11, pod yield (kg/ha) across sites in Malawi

	Ngabu			Chitala		
Cultivar name	**Pod yield kg/ha**	**Kernel yield kg/ha**	**ELS at 100 days**	**Pod yield kg/ha**	**Kernel yield kg/ha**	**Rust score at 105 days**
ICGV-SM 06687	844.4	437.8	3.5	550	357.9	5
ICGV-SM 07501	510	214.8	3	888.9	539	8
ICGV-SM 07502	175.6	57.4	3.5	394.4	241.1	4.5
ICGV-SM 07503	1394.4	495.6	3	700	389.1	7
ICGV-SM 07504	658.9	194.5	3.5	827.8	513.6	6.5
ICGV-SM 07505	300	143	3.5	372.2	235.3	5.5
ICGV-SM 07506	751.1	288.7	3	638.9	367.6	7.5
ICGV-SM 07509	186.7	101.6	3.5	477.8	313.8	6.5
ICGV-SM 07510	435.6	117.1	3	555.6	366.9	5.5
ICGV-SM 07517	637.8	335.9	3.5	355.6	224.9	6
ICGV-SM 07518	1413.3	577.4	3.5	611.1	373	7
ICGV-SM 07520	1193.3	518.4	3.5	1250	727.2	6.5
ICGV-SM 07528	393.3	182.8	3.5	977.8	576.3	6
ICGV-SM 07533	446.7	238.8	3	733.3	484.9	6.5
ICGV-SM 07550	628.9	287.9	3.5	838.9	488.1	5

	Ngabu			Chitala		
Cultivar name	**Pod yield kg/ha**	**Kernel yield kg/ha**	**ELS at 100 days**	**Pod yield kg/ha**	**Kernel yield kg/ha**	**Rust score at 105 days**
ICGV-SM 07553	1523.3	848.5	3	933.3	603.5	6
ICGV-SM 07557	1635.6	719.7	3	1005.6	617.6	8
ICGV-SM 95741	987.8	231.1	3	105.6	49.9	4
ICGV-SM 99568	296.7	169.1	4	616.7	392.7	6
JL 24	1218.9	667.6	6.5	1144.4	750.9	7
Grand mean	**782**	**341**	**3.475**	**699**	**431**	**6.2**
CV	**46.7**	**43.4**	**15.1**	**26.8**	**31.3**	**13.5**
L.S.D	**761.4**	**308.9**	**1.0939**	**390.6**	**281**	**1.745**
P-value	**0.006**	**<.001**	**0.001**	**<.001**	**0.004**	**0.005**

Appendix 4. Effect of genotype – water management soil amendments interaction on aflatoxin contamination (on-station trial)

		Soil amendment factors			
variety	Water management	No lime applied	Lime applied	No Manure	Manure applied
		afb1 (ppb)	afb1 (ppb)	afb1 (ppb)	afb1 (ppb)
ICGV-SM 99568	Open ridges	1532.8	1137.6	1952.1	555.1
	Tied ridges	1306	800.8	589	703.6
J 11	Open ridges	828.1	516.7	733.1	436.3
	Tied ridges	62.1	11.6	74.2	9
Mean					716
CV %					86.8
SED					621.21
Fpr					0.549

Appendix 5. Effect of genotype – time of planting and plant population on rosette incidence (%)

	Time of planting			
	Early		**Late (3weeks later)**	
Plant density	**High**	**Low**	**High**	**low**
Variety				
Chalimbana	5.31	6.84	7.72	14.31
Nsinjiro	0.44	0.72	0.47	0.47

	Time of planting			
	Early		Late (3weeks later)	
Plant density	**High**	**Low**	**High**	**low**
Malimba	3.16	3.16	6.62	7.44
Baka	0.28	0.91	0.38	1.09
Mean				3.71
cv				65
sed				2.713
Fpr				0.188

Appendix 6. Effect of genotype – time of planting and plant population on kernel yield (kg/ha)

	Time of planting			
	Early		Late (3weeks later)	
Plant density	**High**	**Low**	**High**	**low**
Variety	(Kg/ha)	(Kg/ha)	(Kg/ha)	(Kg/ha)
Chalimbana	438	343	498	219
Nsinjiro	870	600	582	437
Malimba	534	399	396	295
Baka	725	439	531	378
Mean				480
cv				55
sed				86.7
Fpr				0.233

Appendix 7. Effect of variety, time of planting and water management on aflatoxin contamination (afb1 [ppb])

	Time of planting		Water management	
Variety	Early	Late (3weeks later)	Box ridges	Open ridges
	Afb1 (ppb)	Afb1 (ppb)	Afb1 (ppb)	Afb1 (ppb)
ICGV-SM 99568	324.7	252.9	210.1	474.5
J 11	156.3	349.7	230.5	271.9
Mean		295		295
Fpr		0.263		0.27
sed		98.7		99.88
cv %		159.2		160.73

Appendix 8. Participatory Variety (Spanish Types) selection in Malawi

Genotypes	Pod Yield (kg/ha)	Kernel yield (kg/ha)	Shelling %	No pod/ plant	ELS at 100 days	Rosette incidence %
ICGV-SM 01514	1422	1039	74.98	26.99	2.97	0.47
ICGV-SM 03572	1365	1057	78.03	29.77	1.86	0.05
ICGV-SM 03576	1585	1148	72.53	29.64	2.35	0.31
ICGV-SM 99551	1549	1008	65.34	25.56	3.62	0.42
ICGV-SM 99556	1492	1046	70.78	28.56	3.87	0.83
ICGV-SM 99567	1390	968	69.74	24.31	3.81	0.52
ICGV-SM 99568	1598	1105	68.31	27.62	4.25	0.1
JL 24	1546	932	60.25	27.25	4.68	3.2
Mean	1493	1038	69.9	27.47	3.38	0.74
cv %	26.2	28.9	14.6	13.2	24.6	156.7
sed	138.4	105.9	3.612	1.278	0.294	0.408
Fpr	0.543	0.535	<.001	<.001	<.001	<.001

Appendix 9. Participatory Variety Selection (Virginia types) in Malawi

Genotypes	Pod Yield (kg/ha)	Kernel yield (kg/ha)	shelling %	No pod/plant	ELS at 100dys	Rosette incidence %
ICGV-SM 01708	983	643	63.17	26.13	1.6	0
ICGV-SM 01731	1059	704	66.1	26.4	1.53	0
ICGV-SM 01724	1523	837	66.9	27.32	1.8	0.17
ICGV-SM 99772	1296	931	71.22	25.8	1.4	0
ICGV-SM 01728	1552	765	66.63	25.4	1.6	0
92R/704	868	471	55.73	24.4	2	1.25
ICGV-SM 90704	1138	807	70.02	26.33	1.66	0
Chalimbana 2005	1053	695	65.59	22.7	2.26	4.92
Mean	1100	732	65.676	25.51	1.733	0.79
cv %	27.9	28.1	14.1	13.2	29.5	146.8
sed	112	75.1	3.39	1.23	0.186	0.474
Fpr	0.005	<.001	<.001	0.004	<.001	<.001

Appendix 10. Variety ranking by traits in Malawi (Virginia Types)

Genotype	Traits Yield	Taste	Ease of shelling	Seed size	Disease resistance	Maturity duration	Total	Rank
ICGV-SM 01708	3	2	3	2	3	3	16	4
ICGV-SM 01731	3	2	2	2	3	3	15	3
ICGV-SM 01724	2	3	2	2	3	3	15	3
ICGV-SM 99772	1	2	2	2	3	2	12	1
ICGV-SM 01728	2	2	2	2	3	2	13	2
92R/704	4	3	4	4	3	3	21	5
ICGV-SM 90704	1	2	3	3	1	2	12	1
Chalimbana 2005	4	2	1	1	4	4	16	4

Scale: 1=excellent, 2=very good, 3=good, 4=average, 5=poor

Appendix 11. Variety Selection across sites in Malawi (Virginia Types)

	Mchinji	**Nkhotakota**	**Mzimba**		
Total no of participants	**319**	**138**	**440**		
Genotype	**% Response**	**% Response**	**% Response**	**Cumulative total**	**Rank**
ICGV-SM 01708	4.39	5.07	7.27	16.73	7
ICGV-SM 01731	7.21	11.59	6.13	24.93	6
ICGV-SM 01724	15.67	11.59	16.14	43.4	4
ICGV-SM 99772	22.88	31.88	12.96	67.72	1
ICGV-SM 01728	17.24	18.84	13.63	49.71	3
92R/704	1.57	0.73	5.91	8.21	8
ICGV-SM 90704	20.06	17.39	25.91	63.36	2
Chalimbana 2005	10.97	2.89	12.05	25.91	5
Total	100	100	100		

Appendix 12. Variety ranking by traits in Malawi (Spanish Types)

Genotype	Traits Yield	Taste	Ease of shelling	Seed size	Disease resistance	Maturity duration	Total	Rank
ICGV-SM 01514	2	2	3	3	2	1	13	2
ICGV-SM 03572	2	3	3	3	2	2	15	4
ICGV-SM 03576	2	3	3	4	2	2	16	5
ICGV-SM 99551	2	1	2	2	2	2	11	1
ICGV-SM 99556	3	2	2	2	3	2	14	3
ICGV-SM 99567	2	2	2	2	3	3	14	3
ICGV-SM 99568	1	3	1	1	3	2	11	1
JL 24	4	1	2	3	4	2	16	5

Scale: 1=excellent, 2=very good, 3=good, 4=average, 5=poor

Appendix 13. Variety selection across sites in Malawi (Spanish Types)

	Mchinji	Nkhotakota	Mzimba		
Total no of participants	**291**	**199**	**388**		
Genotype	**% Response**	**% Response**	**% Response**	**Cumulative total**	**Rank**
ICGV-SM 01514	13.75	16.08	7.5	37.33	4
ICGV-SM 03572	10.31	5.03	9.79	25.13	7
ICGV-SM 03576	9.96	7.53	9.27	26.76	6
ICGV-SM 99551	18.56	18.09	15.72	52.37	2
ICGV-SM 99556	18.9	12.06	13.66	44.62	3
ICGV-SM 99567	3.44	9.55	6.7	19.69	8
ICGV-SM 99568	15.81	17.59	27.06	60.46	1
JL 24	9.27	14.07	10.3	33.64	5
	100	100	100		

Appendix 14. Variety selection across sites in Tanzania

VARIETY	NANYUMBU	NAHAWARA	NANGOMBA	NAMOMBWE	NALUWALE	CHIKOWETI	LUANDA	Mean
ICGV SM 90704	480	700	300	600	700	800	300	554
ICGV SM 02724	800	2500	1120	1300	1400	1000	1300	1346
ICGV SM 05606	600	1400	1060	2200	1500	2000	1280	1434
ICGV SM 01731	560	1900	1020	2100	1500	2000	1320	1486
ICGV SM 01709	400	2900	1200	2600	1500	2400	1960	1851
ICGV SM 02715	600	2400	840	2400	1200	2500	1280	1603
ICGV SM 06513	200	2000	480	1300	900	2000	360	1034
ICGV-SM 05611	280	1000	440	1600	400	1600	480	829
ICGV-SM 90082	200	3700	800	1600	900	1400	720	1331
ICGV-SM 06738	240	1700	240	800	400	1600	1280	894
Mnanje -2009	680	2900	1080	1500	1400	2200	520	1469
Johari	600	600	240	500	400	1200	540	583
MEAN								1201
CV %								36.4
LSD								467
P=0.05								**

Appendix 14. (Contd.)

SITE	Nanyumbu	Nahawara	Nangomba	Namombwe	Naluwale	Chikoweti	Luanda	Reasons
Preferred Varieties	ICGV SM 02724 ICGV SM 01709 ICGV SM 01731	ICGV SM 02724 ICGV SM 06513 ICGV SM 02715	ICGV SM 02724 ICGV SM 01731 ICGV SM 02715	ICGV SM 01731 ICGV SM 02715 ICGV-SM 90082	ICGV SM 01731 ICGV SM 02715 ICGV SM 02724	ICGV-SM 90082 ICGV SM 06513 ICGV SM 02715	ICGV SM 02724 Mnanje -2009 ICGV SM 01709	Yield potential, Pod & kernel size, Tan color

Appendix 15. Rainfall distribution (mm) for the 2010/11 season in Tanzania

	Rainfall Distribution (mm) for the 2010/11 Season										
	Date	**Nov-10**	**Dec-10**	**Jan-11**	**Feb-11**	**Mar-11**	**Apr-11**	**May-11**	**Jun-11**	**Jul-11**	**Total**
Naliendele	1-10	0.3	64.3	19.7	177.1	64.5	100.7	2.6	0.0		
	11-20	6.9	4.5	53.8	195.4	87.5	32.1	8.3	0.0		
	21-31	0.3	20.3	9.9	24.5	115.3	61.2	63.4	0.0	0.0	
	Total	**7.5**	**89.1**	**83.4**	**397.0**	**267.3**	**194.0**	**74.3**	**0.0**	**0.0**	**1112.6**
Nachingwea	1-10	0.0	0.0	31.8	111.8	127.8	66.6	0.0	0.0	0.0	
	11-20	0.0	0.0	24.5	45.3	41.1	28.5	0.0	0.0	0.0	
	21-31	0.0	0.0	5.3	124.3	38.5	84.1	2.9	0.0	0.0	
	Total	**0.0**	**0.0**	**61.6**	**288.1**	**207.4**	**179.2**	**2.9**	**0.0**	**0.0**	**739.2**
Tumbi	1-10	0.7	15.6	20.8	42.2	37.5	58.3	10.2	0.0		
	11-20	26.2	55.8	77.6	3.2	108.8	0.0	0.0	0.0		
	21-31	10.6	26.7	8.0	33.9	124.4	3.0	0.0	0.0		
	Total	**37.5**	**98.1**	**106.4**	**79.3**	**270.7**	**61.3**	**10.2**	**0.0**	**0.0**	**663.5**
Bihawana	**Total**	**108.5**	**238.9**	**143.2**	**167.2**	**62.5**	**0.0**	**3.5**			**723.8**