PAEPARD

FARA Forum for Agricultural Research in Africa

APPROACHES FOR STEMMING AFLATOXIN CONTAMINATION IN THE GROUNDNUT VALUE CHAIN

August 2017

1.0 THE CONSORTIUM PARTNERS

Institution	LOGO	
National Smallholder Farmers' Association of Malawi (NASFAM)		
Eastern Province Farmers' Cooperatives (EPFC) Limited		
Food Agriculture and Natural Resources Policy Analysis Network (FANRPAN)		provide national and regional policy dialogue platforms and the project monitoring, evaluation and learning
Natural Resources Institute, University of Greenwich		Provides world-leading expertise on the implementation of agriculture development projects, advice on mainstreaming gender, and socio economic dimensions value chain development, post-harvest technology, value addition and monitoring and evaluation.
Department of Agricultural Research Services (DARS)		
Zambia Agricultural Research Institute (ZARI)		

2.0 EXECUTIVE SUMMARY

Groundnuts form the basis for food and nutrition security for the majority of the smallholder farmers and are a vital component in the livelihoods of rural families. The challenge is that the groundnuts of these smallholder farmers are prone to *Aflatoxin* contamination. The contamination can occur any time from pre-harvest to post-harvest and has enormous health and economic consequence. Investing in pre- and post-harvest loss research, technical advice and policy advocacy to reduce food losses could significantly increase the food and nutrition security.

The project therefore aims to reduce pre and post-harvest waste in the groundnut value chain (GnVC) and thereby increase food and nutrition security of smallholder farmers in the focal countries. The project intervenes at three levels:

i. Based on the applied research and analysis of major constrains related GnVC, promising pre- and post-harvest practices and technologies are assessed, validated and further developed through participative evaluation in selected rural households;
ii. The successfully tested practices are documented, appropriate dissemination tools and methodologies are elaborated, and farmer capacities are built; and
iii. Based on the evidence gained from the validation of pre- and post-harvest practices and technologies, advocacy and policy dialogues are conducted through multi-stakeholder platforms at the local, national and regional levels with the aim of strengthening these aspects in policies and regulatory frameworks.

By August 2017, the project had documented empirical evidence on the validated technologies which informed extension and policy discussions at national and regional level.

3.0 PROJECT DESCRIPTION

3.1 Background and the definition of the problem

Groundnuts (arachis hypogaea) are a key legume crop grown by smallholder farmers in Malawi and Zambia. It is an important food and nutrition crop in Malawi and Zambia. In Malawi, groundnut is one of the strategic crops in the National Export Strategy with groundnut exports ranked second only to tobacco in terms of foreign exchange earnings. In Zambia, groundnut is the second mostly grown crop after Maize. The importance of groundnuts to the Malawian and Zambian populations is multifaceted. In addition to exports, groundnuts also account for 25 percent of household's agricultural income (Diop et al. 2003). Being a nitrogen-fixing plant they actually improve the soil condition for the following crop and thus are important in a crop rotation strategy to counter reduced soil fertility from over farming. This is particularly important when considered in the context of environmental sustainability and rising prices for chemical fertilizers which make it difficult for farmers to purchase them. However, the return to seeing the historic highs of groundnut production is marred by low productivity, poor quality production, problems of aflatoxin contamination, limited access to certified seed, lack of access to profitable markets and limited access to supporting marketing infrastructure

The decline in groundnut production and exports in the early nineties is largely attributed to the change in market requirements overseas; requirements which Malawi's and Zambia's groundnuts failed to meet. Primarily this pertained to aflatoxin contamination. Aflatoxins are poisons produced by the fungus Aspergillus flavus. They occur naturally in the soil and infect the groundnut pods during pod development or during poor post-harvest handling. Being a food crop, groundnuts are subjected to rigorous maximum allowable levels of aflatoxin contamination. Allowable levels differ from country to country with Japan pegging it at 0 parts per billion, European Union at 4 parts per billion and South Africa at 10 parts per billion. Otsuki et al, 2001 suggested that the reduction of aflatoxin maximum allowable levels resulted in annual losses of over US$670 million for African countries. The reasons for the high levels of aflatoxin contamination in Malawi/Zambia groundnuts can easily be identified at a circumstantial level, evidenced by a number of practices that farmers are engaged in (such as soaking nuts prior to shelling) that increase the chances of contamination.

The need to control aflatoxin contamination is often promoted solely in terms of improving access to export markets. However, a growing body of research, shows that consumption of dangerous levels of aflatoxin is a real and serious health issue. These groundnuts are fed to many of our most vulnerable groups, including the young, the malnourished and the aged, as nutritional supplements. Thus, whether grown for export or local consumption, there is urgent need to improve practices so that the incidence of aflatoxin is minimised.

Through the year 2000's there have been various interventions that have been promoted at farmer level in response to the aflatoxin challenge. Despite these, adoption of the technologies has been low and so have the levels on knowledge, positive attitudes and practices of actors along the groundnut value chain. It is for this reason that the consortium was formed to address these challenges

3.2 Objectives of the project

The goal of this project was to ***reduce pre- and post-harvest losses by focusing on reducing Aflatoxin in the GnVC*** for improved food and nutrition security of smallholder farmers by addressing main constraining factors of technology dissemination and adoption, knowledge and information sharing, and policies. The specific objectives of the project were:

1. To conduct research and identify, further validate and disseminate successful Aflatoxin contamination reduction practices and technologies adapted to specific socio-economic and socio-cultural contexts within the GnVC that is benefitting smallholder farmers in the focal countries.
2. To reach scale and sustainability in the adoption of good Aflatoxin contamination reduction practices and technologies through innovative approaches in farmer-led Rural Advisory Services (RAS), capacity-building and effective knowledge management.
3. To address policy constraints related to Aflatoxin contamination reduction issues through increased awareness of policy makers and through fostering of

effective mechanisms for learning and sharing of experiences of Aflatoxin contamination reduction.

3.3 Project Research questions and methods

Research Question 1: *What are the promising practices and technologies that relates to production, income and gender pathways that has a potential to reduce Aflatoxin contamination in the GnVC?*

Major constrains related to production, income and gender pathways to enhance the GnVC, promising practices and technologies were assessed and validated through participative evaluation by women and men at farm and community level.

Research Question 2: *What are the best ways to compile, disseminate and scale up good practice/technology options for reducing pre- and post-harvest losses due to Aflatoxin contamination?*

The project relied on capacity building initiatives and awareness campaigns to disseminate prioritized practices and technologies in the focus areas.

Research Question 3: *What are and how can appropriate Aflatoxin regulatory frameworks and conducive policies on reducing pre- and post-harvest losses in GnVC at national and regional levels be advocated?*

Outputs from Research Questions 1 and 2 laid the basis of evidence-based advocacy and policy dialogue on GnVC Aflatoxin contamination reduction related issues

Project progress

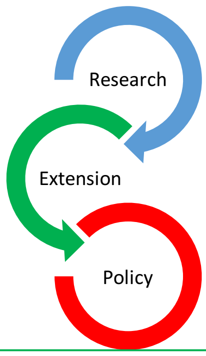
4.1 Project Implementation Approaches

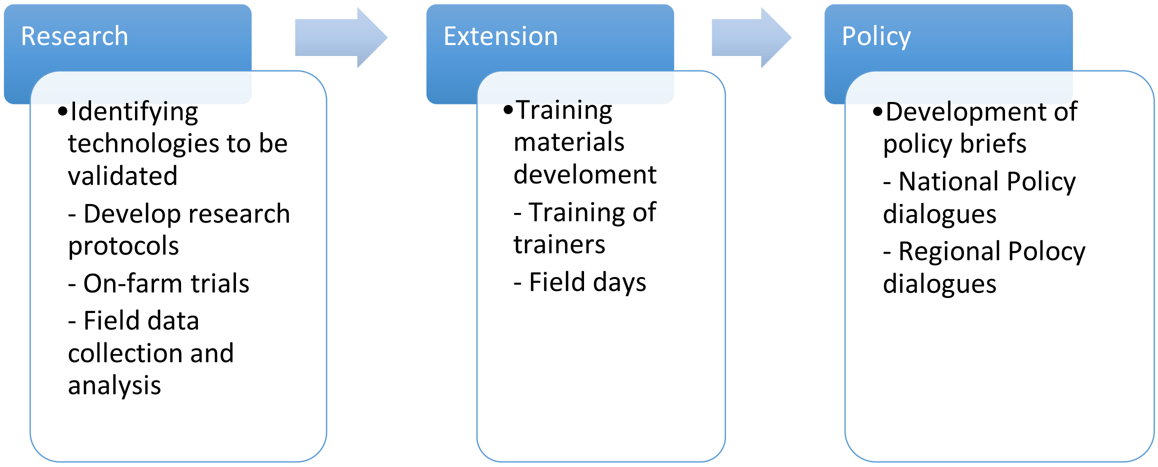
The implementation modalities within the project was based on the principles of participatory and integrated approaches that take cognisance of needs and interests of the target group and ensure sustainability mechanisms are built within the project. The following implementation approaches were used;

- **Participatory Research:** The researchers employed their knowledge and thoughts in addition to integrating farmers' reflection, engagement and self-investigation. This was employed at all levels following a pluralistic orientation to aflatoxin management and postharvest management
- **The Collective Action Approach**: Capitalising on the successes of organised farming, farmer groups were promoted through strengthening existing and new farmer clubs within the target areas. The farmer group approach is a tried and tested approach which NASFAM and EPFC use to yield economies of scale and strengthen the social capital.
- **Farmer to Farmer extension methodology:** This project employed a farmer-led rural advisory service. In this approach, high performing farmers are democratically selected as lead farmers and they team up with extension officers to provide information to fellow farmers. The approach is designed to spread best practices using locally based human resources, without the costs associated with the employment of large numbers of college-trained extension workers. The approach also works to strengthen farmer involvement and thus ownership.
- **Evidence-based policy influencing:** The project based on findings of research to develop policy briefs, posters and engage in cooperative advocacy initiatives through policy dialogues and information sharing with policy makers.

4.2 Activities.

The project activities were divided in three interlinked themes i.e. Research, Extension and Policy as outlined below





At the heart of the project activities were smallholder farmers who were drawn from the NASFAM and EPFC membership base. In both Zambia and Malawi, farmers in existing clubs were identified and registered to participate in the project. The farmers participated at two levels;

i) Lead farmers who took part in the participatory research: These farmers allocated a portion of their land for instituting the research protocols and their plots were the center for on-farm demonstrations and field extension days.

ii) Farmers who received extension messages: These were targeted directly and indirectly through the extension services mechanism of the farmer organizations. These was through one-on-one extension delivery, publications and radio broadcasts.

4.2 Project Results/outcomes

The project intended to reach out to 8000 famers in Zambia and Malawi. At the time of writing up this case study, a total of 5708 farmers were reached through the tiered targeting system (i.e. lead farmers and farmer members in NASFAM and EPFC). These are the direct or ultimate beneficiaries whom the project targeted with one-on-one extension/advisory services, provision of seed, production training, marketing training and general good crop management trainings. These beneficiaries are the ones who were engaged for adaptive research to ensure uptake of extension messages and multiplier effects. Groundnuts, has for a long time being referred to as a *'woman's crop'* and in this project the majority (over 50%) of the beneficiaries were women.

In general, Table 1 below highlights noticeable short term impacts on the beneficiaries and highlights anticipated long term impacts.

Table 1: Project beneficiary short and long term impacts

Beneficiaries	Outcomes
1. Ultimate beneficiaries (i.e. smallholder farm families)	• Increased uptake of GnVC post-harvest loss management practices and technologies. • Reduced groundnuts post-harvest losses leading to increased food availability, increased income generation
2. Intermediate beneficiaries (i.e., intermediaries)	• Increased knowledge of Aflatoxin contamination in GnVC to bridge the gap between research, policy and practice by synthesizing and communicating GnVC research evidence.
3. Policy makers	• Ability to appraise and use GnVC research evidence in decision making to support integrated policy processes, investment decisions and programming.

4.2.1 Result 1: Promising practices and technologies that relate to production, income and gender pathways that have a potential to reduce Aflatoxin contamination in the GnVC identified, further validated and disseminated.

The project identified 9 pre and post-harvest technologies but later focused on 5 technologies/practices for evaluation and validation in Malawi and Zambia as elaborated below

1) *Optimizing plant densities for reduced aflatoxin contamination*

Inter and intra row spacing affect plant populations, canopy closure, water use, quality and quantity of yields of any plant. Well closed canopy conserve moisture. On the other hand very high plant densities compromise plant vigor and increase plant vulnerability to diseases and pests.

2) Evaluating the role of crop residue on pre-harvest aflatoxin contamination of groundnut

Farmers traditionally remove crop residues before planting groundnuts. They claim residues increase the chance of pre-harvest mould proliferation in nuts. Ideally residues are thought to reduce risk of moulds development through moisture conservation and support of trichoderma which counteracts toxigenic funngi. On the other hand groundnuts pods develop underground (direct contact with crop residues), if these residues provide inoculum of aflatoxigenic

3) Participatory evaluation of hand-sorting methods in reducing aflatoxin contamination

Farmers are being encouraged to sell their groundnuts in shell. The current trial seeks to evaluate the effect of in-shell kennel sizing on the effect of partitioning aflatoxin into various shelled groundnut grade sizes. The trial will further validate the effect of o kennel sizing and hand sorting of both shelled and in shell nuts on aflatoxin reduction

4) Participatory evaluation of drying methods for reducing aflatoxin contamination

Mandela cock groundnut drying technology has been promoted by many NGOs. It is a structure that uses the free flowing air to gradually remove moisture from pods. It is generally claimed by many that it reduces aflatoxin content. However there is lack of efficacy data. The present intervention aims to bridge that gap

5) *Evaluation of effect of tie/box ridging and of number of rows per ridge*

Having implemented the research protocols in collaboration with farmers, data was collected and analyzed to assess the effect on aflatoxin contamination. To-date, a total of three research posters have been developed to share findings and initiate dialogues.

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FARMER-LED EVALUATION OF THE EFFECT OF DOUBLE ROW PLANTING PATTERN AND CROP RESIDUE INCORPORATION ON YIELD, MOULD PREVALENCE AND AFLATOXIN CONTAMINATION IN GROUNDNUTS

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Background

Recently, **FOs/NGOs** in Malawi and Zambia have been **advocating** for **shift from planting single row/ridge to double rows in groundnut** cultivation. On the other hand, **farmers believe crop residues act as a source of fungal inocula and increase the risk of insect damage in groundnut fields** and therefore they remove the crop residues. Unfortunately, there has not been any systematic scientific evaluation of the two practices on **yield components, pre-harvest mould prevalence and aflatoxin contamination in groundnuts**. Therefore, this research is aimed to bridge these gaps.

The Experimental

- The problems were tackled in two separate experiments initially involving a total of 100 farmers across 4 districts in Malawi namely Lilongwe, Ntchisi, Dowa and Mchinji (2015/16 growing season).
- Each participating farmer provided two fields (10 ridges by 10m) and treatments were assigned randomly to each pair of fields by flipping a coin.
- Experiments were planted with first rains, and experimental conditions were laid with the help of extension staff (Table 1).
- Farmers were encouraged to keep their fields weed-free and no inorganic fertilizers were applied as is the practice in Malawi.
- The experiments were harvested between 120–140 days after planting and a summary of the most import variables captured at harvest and the methodology are outlined Table 2.
- A 1 kg sample of groundnuts was collected and immediately ground (in-shell) using a laboratory blender and subsample stored in freezer until HPLC aflatoxin analysis.

Table 1: Experimental Conditions

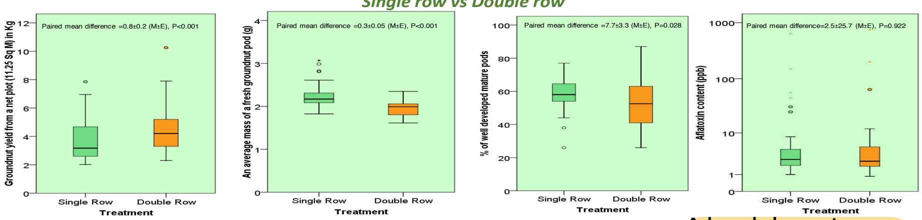
	Experiment 1: Double vs Single row		Experiment 2: Crop residue incorporation vs removal	
Treatment	Single row	Double rows	Residue incorporated	residues removed
Ridge spacing (cm)	75	75	75	75
Distance between plants in a row (cm)	15	15	15	15
Variety	CG7	CG7	CG7	CG7

Table 2: Field Data Capturing

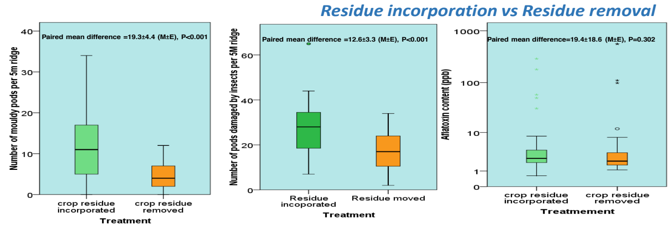
Variable	Methodology
Yield	Fresh mass of groundnuts (in pods) from central net plot of 3 ridges by 5m
Average pod size/ mass	Count of fresh pods making up 1 kg mass
% of well developed and mature pods	Visual assessment carried by trained personnel
Mouldy pods	Count of mouldy pods observed within a 5m ridge
Insect damaged pods	Count of insect damage pods observed within a 5m ridge

Preliminary Findings

Single row vs Double row



Residue incorporation vs Residue removal



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Preliminary Conclusions

- Double row pattern significantly increases groundnut pod mass yield (approx. 20%) but significantly compromises pod development and size. However, there is no significant difference between single and double row pattern in terms of aflatoxin levels at harvest.
- Incorporating previous crop residues into groundnuts field significantly increases risk of pre-harvest mould development and insect damage. However, the residue incorporation has no effect on aflatoxin prevalence which indicate that the spoilage moulds observed at harvest are not necessarily aflatoxin producers.

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MANAGING AFLATOXIN IN SMALLHOLDER GROUNDNUT PRODUCTION IN SUB-SAHARAN AFRICA: PAIRED COMPARISON OF THE WINDROW AND MANDELA COCK TECHNIQUES

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BACKGROUND

Prompt moisture content reduction in harvested groundnuts is critical for safe storage. In most parts of sub-Saharan Africa, moisture content reduction is practically achieved by natural solar drying. In this region, extension agents have traditionally advocated for inverted windrows (Figure 1). However, recently Mandela Cork technology (Figure 2) has been introduced in Southern Africa. The current study was carried out to systematically compare the performance of the two methods with respect to aflatoxin control

Fig 1: Traditional inverted windrow

THE EXPERIMENTAL

- The experiment involved 29 farmers during the 2015/16 growing seasons and 26 farmers during 2016/17 season
- Farmers planted with CG 7 groundnut variety with first planting rains.
- Farmers were encouraged to keep their fields weed-free and no inorganic fertilizers were applied as is the practice in Malawi.
- The experiments were harvested between 120–140 days after planting
- Each participating farmer was asked to dry the nuts using inverted windrow and Mandela cork methodology.
- Aggregated 2-5 kg sample of groundnuts were collected from each treatment per farmer and analyzed for aflatoxin. Paired T-test were performed to compare treatment means

Fig 2: Mandela Cork

RESULTS

Windrow vs. Mandela cork

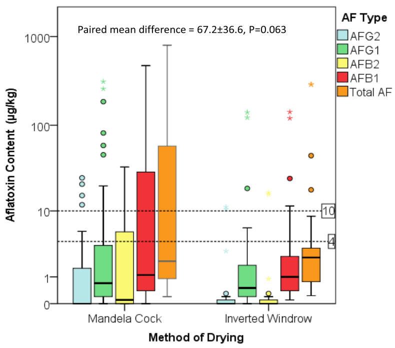

Fig 3: Comparison of aflatoxin contact 2015/16

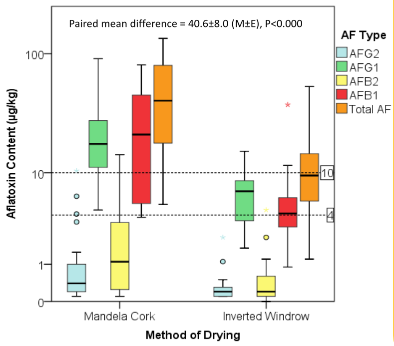

Fig 4: Comparison of aflatoxin contact 2016/17

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PRELIMINARY CONCLUSIONS

- Mandela cork groundnut drying consistently resulted in significantly ($P<0.10$ in 2016 and $P<0.001$ in 2017) higher aflatoxin levels compared to the traditional inverted windrow drying in Malawi.
- Further research need to be carried out to identify feasible and more safe groundnut drying techniques
- Considering that the Mandela Cork technology was introduced in the region without conducting efficacy trials, the present findings clearly demonstrate the need for strict government regulation and technology validation if farmers are to benefit.

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Immediate outcomes of research activities have been the following;

- Farmer-led research and having farmers at the centre of validating technologies
- Demystifying the myths about aflatoxin as it relates to health
- Rethinking the impact of pluralistic extension service regulation
- Promoting alternatives pre and post-harvest practices

4.2.2 Result 2: Innovative approaches in farmer-led Rural Advisory Services (RAS), capacity-building and mechanisms for knowledge management, learning and sharing of experiences compiled, disseminated and scaled up and out.

In order to ensure that farmers were aware of the problem of Aflatoxin in groundnuts and have the requisite knowledge and skills to reduce contamination of groundnuts a number of methodologies were deployed and these were;

Sensitization meetings: Although some farmers are aware of Aflatoxin and its health hazards, the level of awareness among a lot many farmers was still low. As a result, farmers continue to produce groundnuts which are heavily contaminated. Worse still, they continue to consume the heavily contaminated groundnuts thereby putting themselves at risk of such effects as cancer and immune-suppression. Therefore, there was need to conduct sensitization meetings with all stakeholders starting with farmers who are the producers.

Leaflets: Participants in sensitization meetings were provided with leaflets carrying information on causes of Aflatoxin contamination in groundnuts, its effects on the health of human beings and animals, and how farmers and other value chain players can reduce contamination in groundnuts.

Demonstrations: On-farm demonstrations serve as one of the most effective Extension education tools ever developed. Although complete demonstrations require considerable time and effort, the payback comes when producers more readily adopt practices they perceive to be appropriate under local conditions - seeing is believing.

Field days: Field days are the climax of any demonstration that is showcasing good agricultural practices. They act as a forum where all stakeholders participate to critique the technologies that are being showcased and make necessary recommendations, in a participatory manner, on the best technologies or practices that farmers should adopt in order to improve their yields. In line with the foregoing, each demonstration had two field days, pre and post-harvest. The former gave farmers an opportunity to appreciate good agricultural practices in groundnuts. The latter, on the other hand, enabled farmers to appreciate the effect of the Mandela Cock on drying of groundnuts and the effect of double row planting.

Farmer Training: Participating farmers were trained in good agricultural practices in groundnut production as well on how to collect crop performance and environmental data from the demonstration plots

4.2.3 Result 3: Appropriate recommendations on reducing Aflatoxin-related pre- and post-harvest losses in the GnVC tabled at national and regional levels.2.2. Knowledge sharing events conducted.

The work of the GnVc consortium centered on the notion of science to policy. In this regard, the research results formed the basis for engagement in national, regional and global policy discussion and debates. In order to contribute to the regional policy formylation processes the annual FANRPAN policy dialogues provided a necessary platform to reach out to wider stakeholders on the issues of general postharvest management and the zeroing on the aflatoxin problem. Below are some of the key recommendations that have been made in Malawi, Zambia and at regional level.

Key recommendations for Stemming Aflatoxin in the groundnut value chain

- Develop policy frameworks that encourage and promote the participation of entrepreneurs along the groundnuts value chain with a specific bias to reducing PHL and improved market access.
- An integrated approach throughout the groundnut value chain is required to stem aflatoxin contamination in Africa. Collaborative multi-stakeholder partnerships are critical.
- There is a need for increased funding by governments and development partners for the establishment and enforcement of standards. These standards should be at par with the international standards on aflatoxin control.
- Research and development should be a key pillar in reducing aflatoxin contamination. Conventional research should take into account the traditional knowledge on aflatoxin control.

4.3 Sustainability.

Prior to 2014, researchers, policy advocates and farmer organizations were not necessarily working together on the basis of clearly defined mutual objectives and a shared understanding of the needs. This project, has planted lasting collaboration mechanism that has transformed the nature of of working together from cooperation to collaboration as demonstrated in the figure below;

The consortium is moving from short-term, informal relationships to a more durable and pervasive relationship where is it not concerned with sharing information only but engaging in joint planning, shared commitments to common goals and all partners contribute and share rewards and leadership.

By design, farmer organizations are a vehicle through which farmer involvement in research and policy is strengthened and guaranteed. As institutions they go beyond project life cycle to establishing sustainable farmer owned and managed institutions. The project capitalized on this rich institutional structure to inject a new software of farmer involvement which ill last beyond the project life.

Project partners have in the course of implementation been exposed to various capacity strengthening workshops in communication, resource mobilization and project implementation which have enhanced the capacities to work with other players in different value chains.

Lessons learnt

There have been many lessons that have been drawn during project implementation.

Project Success factors

a) *Commitment:* At the center of what the project achieved lies the commitment of consortium partners and individuals.
b) *Planning:* At the start of project activities every year, the project team was undertaking careful planning especially on the research component as it was the basis for extension and policy interventions. With this level if planning, explicit roles and responsibilities were assigned to each component with component leads.
c) *Linkages with other initiatives:* The project capitalized on ongoing initiatives at national and regional level. For instance, collaboration with Malawi Partnership for Aflatoxin Control (MAPAC) in Malawi was established to increase awareness and implanting joint advocacy actions. At regional level, FANRPAN has been implementing a Post-Harvest Management and Climate Smart Agricultural programs which have had a bearing on aflatoxin management. Through national and regional policy dialogues, the project work was amplified on the available platforms and wider post-harvest management issues provided a reference point
d) *Farmer buy*-in:
e) *Student involvement*
f) *Project outputs dissemination: T*he project utilized the social media platforms (twitter, facebook), posters to showcase and present findings and recommendations to private sector, public sector and development partners

Project Constraints

There have been many challenges in implementing the multi-stakeholder partnership project. The most important to be highlighted are:

- **Agriculture seasonality challenge:** Delayed project start meant missing some critical seasonal activities leading to refocusing on research areas especially for the 2014/2015 agricultural season. In 2017, due to erratic rainfall that led to a longer rainfall season affecting the drying of groundnuts.
- **Project coordinatio**n: The project experienced challenges related to team forming and norming in the first year which was overcome by a well-coordinated planning and clarifying on roles and responsibilities as well as expectations.
- **Communication between partners:** feedback sometimes didn't come on time when needed which led to fatigue. Online communication platforms like skype, emails proved challenging due internet connectivity issues etc. More bilateral contact hours between project coordinators/leads were a better alternative.
- **Staff changes**: turn-over of staff in different partner institutions. Also the only one focal person assigned to the project is not enough to bring all required expertise.
- **Liquidation of EPFC**: One of the key partners in Zambia went under and this affected the number of farmers that could have been reached by the project and the level of extension services provided especially for 2016/2017 season. To ensure that the project meets its objective especially on advisory services, NASFAM provided backstopping services to farmers in Zambia.
- **Limited budget affecting the level of involvement:** To mobilize the required expertise and ensure adequate level of involvement, the project needed financial resources allocated for human resources. This was not the case and it affected the efforts of other partners. Nevertheless, due to high commitment of other partners, a pull effect worked to the advantage of the project.

CONCLUSION