Farmer's trial legume technology evaluation in the districts of Mchinji and Salima in Central Malawi

(N2Africa Project)

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Period: MARCH 2011 – JULY 2011

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SUMMARY

The yields of maize in Malawi are generally low under smallholder farmers. However this can be improved through introduction of legumes in the farming system. Grain legumes have been recognized worldwide as an alternative mean of improving soil fertility through their ability to fix atmospheric nitrogen, increase soil organic matter and improve general soil structure. The promotion of legume technologies needs to take into consideration other benefits, not just soil fertility improvement, if they are to be accepted. The land allocated to legumes remains low as compared to other crops (maize, tobacco) which are considered to be of social and economic importance. The fluctuation of legume prices especially for soybean and limited access to improved technologies of production such as use of inoculants and improved varieties contributes to low investment. The purpose of this study was to evaluate of the performance of legume. A comparison was made between the 2 districts of Salima and Mchinji on the legume trial packages especially soybean trial package to evaluate the technology suitability. Four types of legumes tested included: groundnut, soybean, bean and cowpea with different varieties. Planting was done between late December 2010 and late January 2011. Triple super phosphate (TSP) fertilizer was applied to the trial plots for all legumes whereas soybean was also inoculated with Marondera (Zimbabwe) or Chitedze (Malawi) inoculants. The extension agents involved in dissemination included Clinton Hunter Development Initiative (CHDI) and Department of Agriculture Extension services (DAES). The data were collected through interviews from famers participating in the project. A total 96 farmers were interviewed; 52 from Mchinji (Kalulu and Mkanda Extension Planning Area - EPA) and 44 from Salima (Chinguluwe EPA). Thirty farmer clubs participating in the project were targeted. The area under legume production was analyzed and expressed as proportion of total land being owned by individual farmers in the two districts. The yield estimates were determined based on the grain weight from the whole trial plot (20 x 10) m^2 or net trial plot (16x6) m^2. It was not possible to assess the total biomass because most famers did not weigh stovers hence the analysis is based on grain weight only. Access to extension services were assessed by interviewing farmers to inquire if both lead and secondary farmers had been visited by extension workers. The study results showed that the use of inoculants, fertilizer and right varieties improved legume production in smallholder farming systems. However the land allocated to legume production was small compared to the total

available land. The implementation of large scale projects through partners is an effective way to reach more communities. However the assessment of partners should include availability of human capital at grassroots level. This contributed to differences in technology performance apart from biophysical and agronomic factors differing between Mchinji and Salima.

1.0. INTRODUCTION

The internship was conducted in Malawi in the districts of Mchinji and Salima from 17th March to 17th July 2011 in N2AFRICA PROJECT. The work involved collecting data and monitoring the performance of lead and secondary farmers involved in dissemination of N2AFRICA project interventions and technology evaluation of four legumes (soybean, bean, groundnut and cowpea). The project provided seeds, fertiliser and inoculants as part of technology promotion to lead farmers (responsible for running demonstrations) and secondary farmers (satellite) in Mchinji, Salima, Lilongwe, Dowa, Dedza and Ntcheu.

The yields of maize in Malawi are generally low under smallholder farmers however this can be improved through introduction of legumes in the farming system. Grain legumes have been recognized worldwide as an alternative means of improving soil fertility through their ability to fix atmospheric nitrogen, increase soil organic matter and improve general soil structure (Maobe et al, 1998). In two years of on-farm experimentation, grain yields from legume-intensified systems were comparable to yields from continuous sole maize with the use of chemical fertilizer, even in dry lakeshore ecology (Snapp *et al*., 2002). They also concluded that adoption and soil fertility benefits may depend on market returns to legume production. In Kenya a research conducted by ICRAF showed that annual grain legume-based cropping systems were 32–49% more profitable than continuous sole maize, making them attractive to small farmers in semi-arid tropics (Rao and Mathuva 2000). Therefore promotions of legume technologies need to take into consideration other factors than soil fertility improvement. The land allocated to legumes remains low as compared to other crops (maize, tobacco) which are considered to be of social and economic importance. Food security is measured mainly based on availability of enough maize hence even extension services tend to be biased towards increasing its production. A research conducted by Chibwana *et al.* (2011) on cropland allocation effects of agricultural input subsidies in Malawi, found positive correlations between participation in the program and the amount of land planted with maize and tobacco. Furthermore, results suggest that participating households simplified crop production by allocating less land to other crops (e.g., groundnuts, soybeans, and dry beans). The fluctuation of legume prices especially for soybean and access to improved technologies of production such use of inoculants and improved varieties contributes to low investment in the crop. Research has shown that legumes such as soybean, groundnuts and bean have additional benefit of biological nitrogen fixation but these benefits are yet to be seen by smallholder farmers.

The data was collected from 96 farmers from Kalulu, Mkanda and Chinguluwe Extension Planning Areas (EPA). This was possible with the help of N2Africa team and partners Clinton Hunter Development Initiative (CHDI) and Department of Agriculture Extension services (DAES) participating in dissemination activities. The report is focusing on the analysis of the trial package evaluating technology performance under farmer management in term of attained grain yields. It goes further to analyze the reasons behind variations in performance such as biophysical conditions, agronomy and access to extension services.

1.1. Purpose of the report

The purpose of this report is to give an overview of the performance of technologies being promoted in N2africa project in Malawi and assess the role of agronomic practices, biophysical and extension services factors. A comparison is made between the 2 districts especially on soybean trial package to evaluate the technology suitability. The last part of the report gives my learning outcomes during the 4 months I have been with the N2Africa project at Chitedze and in the impact areas.

2.0. MATERIALS AND METHODS

The data was collected using a field book for technology evaluation (questionnaire) developed by N2Africa. The data was collected through interviews from famers participating in N2Africa project in Malawi in the districts of Mchinji and Salima. A total 96 farmers were interviewed; 52 from Mchinji (Kalulu and Mkanda EPA) and 44 from Salima (Chinguluwe EPA). The 7 agriculture sections manned by Agriculture Extension Development Officers were sampled and 30 farmer associations participating in the project were targeted with aim of gathering data from all the trial packages tested under farmer management. The interviewed farmers included 30 lead farmers and 66 secondary farmers (satellite) who received trial packages comprised of soybean, bean, groundnut, cowpea, inoculants and fertiliser. The questionnaire had 7 parts; general information, trial site, information on use of package, cropping calendar, harvest, farmer assessment and extension services.

The area under legume production was analyzed and expressed as proportion of total land being owned by individual farmers in the two districts. The yields estimates were determined based on the grain weight from the whole trial plot (20 x 10) m^2 or net trial plot (16x6) m^2. The grain weight was determined by weighing the grain then converted to yields per hectare. The weighing of yields from individual trials was done by lead farmers and sampled secondary farmers within each club using scale from extension workers. It was not possible to assess the total biomass because most famers did not weight stovers hence the analysis is based on grain weight only. It should be also noted that moisture content was also not taken into consideration. Access to extension services were assessed by interviewing farmers to ascertain if both lead and secondary farmers had been visited by extension workers. Farmers were also asked to assess the treatments relative to their own fields by scoring ranging from no improvement to highly improved but results from this activity are not included in this report.

2.1. Descriptions of the trials

Dimensions of individual trial plots were 20 × 10 = 200 m^2 and net dimensions per plot for lead famers were 16 × 6 = 96 m^2. The lead farmers harvested net plots while secondary famers harvested whole plots. The example of trial lay out is presented in the Appendix I.

Four types of legumes were grown which included; groundnut, soybean, bean and cowpea. These crops were planted between late December 2010 and late January 2011. Fertilizer (TSP) was applied to the trial plots for all legumes whereas soybean was also inoculated with Marondera or Chitedze inoculants.

2.1.1 Soybean

Soybean was the only crop which was distributed in both districts. The trial package composed of 2 treatments: soybean + TSP and soybean + TSP + inoculants. Soybean varieties tested included Nasoko, Ocepara 4 and Makwacha. Lead farmers had three plots depending on the trial package to be tested. The third plot was suppose to reflect the traditional way of growing the soybean under farmer management including use of local seed. The secondary farmers mostly planted 1 plot of the trial package.

2.1.2. Groundnut

Groundnuts were distributed in Mchinji with the following treatments: groundnut + TSP + variety (Chitala or Nsinjiro). Lead farmers had three plots depending on the trial package to be tested. The third plot was suppose to reflect the traditional way of growing the crop under farmer management using of local seed. However due to lack of local soybean varieties, lead farmers in most used seed from the trial package but managed in traditional way. The secondary farmers mostly planted 1 plot of the trial package.

2.1.3. Bean

Bean trial package was again distributed in only Mchinji because in Salima (Chinguluwe EPA) is not a bean growing area. The bean treatments included; bean + TSP + variety with lead farmers having 3 plots and secondary farmers 1 plot. The varieties planted were Maluwa and Napilira. However, it was observed that most lead farmers and clubs received 1 variety for testing. This meant planting same variety in the 3 plots making it difficult to assess varietal impact. The difference was that in the control plot TSP was not used and traditional way of growing beans was followed.

2.1.4. Cowpea

Cowpea was distributed in Salima with the following treatments; cowpea + TSP and cowpea + TSP + maize. The variety planted was IT16. Lead farmers had three plots based on the trial package.

2.2. Statistical analysis

The data was analysed using SPSS and excel looking at farm size, average grain weight yields of the individual legumes and trial plots, different treatments among the trial packages, differences in average grain weight yields between the Salima and Mchinji and variation in yield based on trial packages. The independent t test was used to compare average or mean (M) grain weights and standard error of mean (SE) from the two districts. To assess extension services or dissemination; descriptive statistics were used to look at the percentage of farmers visited by fellow farmers in the area or who got advice from agricultural extension officers. This was important to evaluate how farmers are linked to extension services as part of capacity building to enhance farmers' field management skills and knowledge for legumes production.

3.0. RESULTS

3.1. Land/farm size

The total farm size for the interviewed 96 farmers was approximately 301.1 ha. The land distribution varied among farmers; 15 farmers had land between 0.4 and 1 ha, 53 farmers between 1.1 and 3 ha, 9 farmers between 3.1 and 5 ha, 16 farmers between 5.1 and 10 ha and 3 farmers between 10.1 and 24 ha. A total of 62.29 ha (21%) allocated to legume production. The largest part of land under legume production was allocated to groundnut production (Fig1) with cowpea coming second.

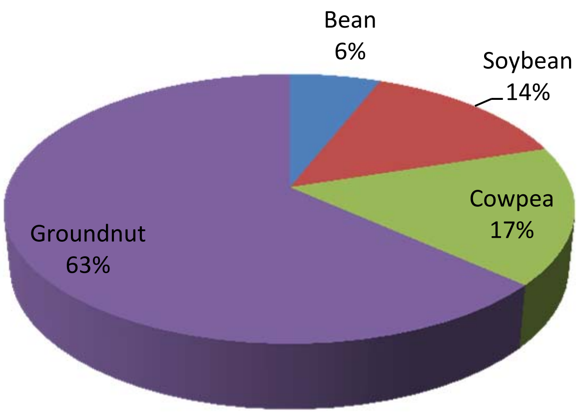

Figure.1. Percentage of legume land under groundnut, bean, cowpea and soybean in Mchinii and Salima districts

The amount of land allocated to different legumes was different between the two districts (Fig.2 and 3.). In Mchinji more land was allocated to groundnut and soybean production while in Salima more land was allocated to groundnut and cowpea production. Bean and cowpea legumes were grown only in Mchinji and Salima respectively.

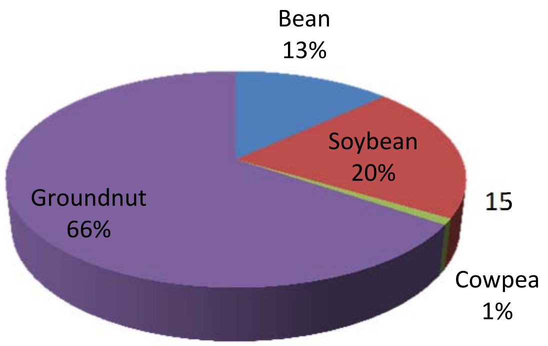

Figure.2. Percentage of legume land under groundnut, bean and soybean in Mchinji

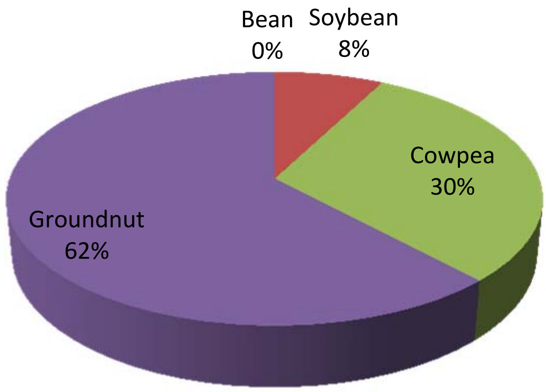

Figure.3. Percentage of legume land under groundnut, cowpea and soybean in Salima district

3.2. Soybean trial package

On average, soybean + TSP + inoculants gave higher grain yields (M = 1204 kg/ha, SE = 90.34) than soybean + TSP (M = 733 kg/ha, SE =139.91). These are average grain yields from Nasoko and Makwacha varieties excluding local varieties. The difference was significant $t(93) = -2.642$, $p<.05$. The average grain yields were different (Fig 4) with Salima (M=1120 kg/ha, SE = 106.59) compared to Mchinji with average yield (M =1033 kg/ha, SE = 93.10). This difference was not significant $t(109) = -.612$, $p > .05$ and it represented low sized effect r = 0.06.

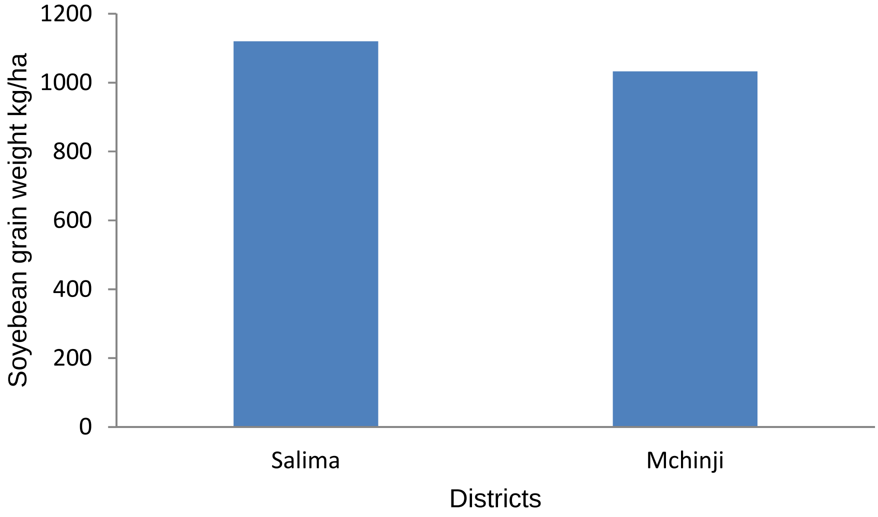

Figure.4. Average soybean grain yields kg/ha for Salima and Mchinji districts

Soybean + TSP + inoculants (Fig.5.) had higher grain yield (M = 1332.65 kg/ha, SE = 157.49) in Salima than Mchinji (M= 1165 kg/ha, SE = 168.07) but the difference was not significant $t(51) = -.726$, $p > 0.05$; however, it did represent a small-sized effect $r = 0.10$. Soybean + TSP had higher grain yield in Salima than Mchinji but the difference was also not significant

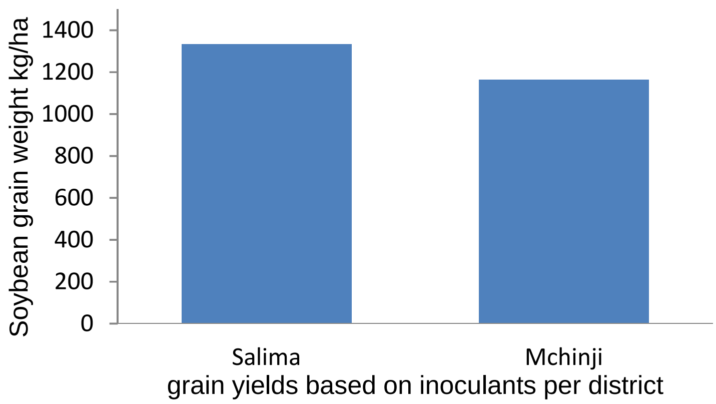

Figure.5. Average soybean grain yields kg/ha of inoculated soybean for Salima and Mchinji Districts

The analysis on inoculants type (Fig .6.) in Salima showed higher grain yield on average for Marondera than Chitedze. However the difference was not significant $t(24) = -1.899$, $p>0.05$. The average soybean grain yield for Chitedze was lower than the control. The yields were from different farmers who used either Marondera or Chitedze inoculants.

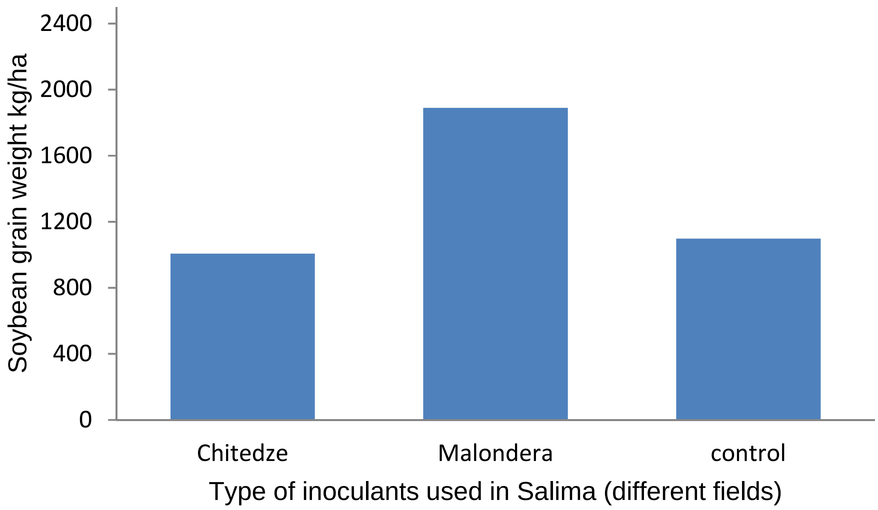

Figure.6. Average grain yields kg/ha of inoculants types in Salima District

3.3. Groundnuts package

The total average grain weight yield in Mchinji was 576 kg/ha. The higher average grain weight yields were obtained where TSP (M = 707 kg/ha, SE = 135.48) was applied than where no TSP (M= 185 kg/ha, SE = 47.37) was applied in Mchinji. The difference was significant $t(23.994) = 3.633$, $p<.05$ (equal variance not assumed). Chitala variety with TSP had higher average grain yield (895 kg/ha) compared to nsinjiro (393 kg/ha) variety with TSP applied (Fig. 7.). The low yields can be attributed to late planting.

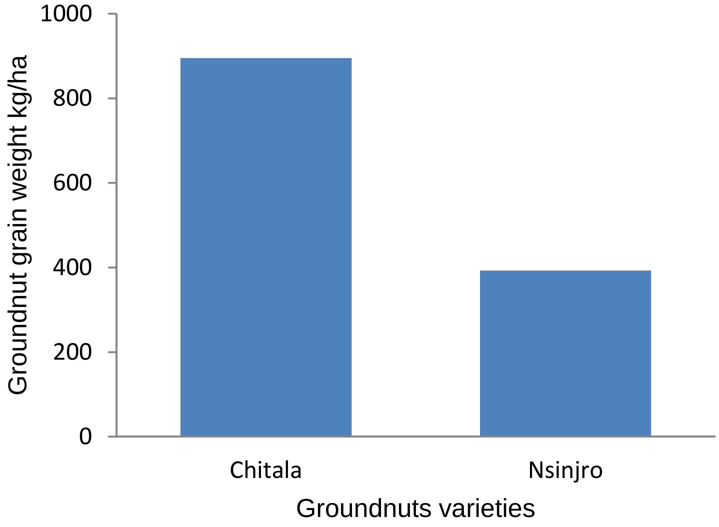

Figure.7. Average grain yields Kg/ha of the two groundnut varieties in Mchinji

3.4. Cowpea

Total average grain weight for cowpea in Salima was 684.55 kg, and the higher average grain yield was obtained where TSP fertilizer was used compared to no fertilizer (Fig .8.) use. The average grain yield for TSP treatment was higher than the overall yield. However the yield difference was not significant.

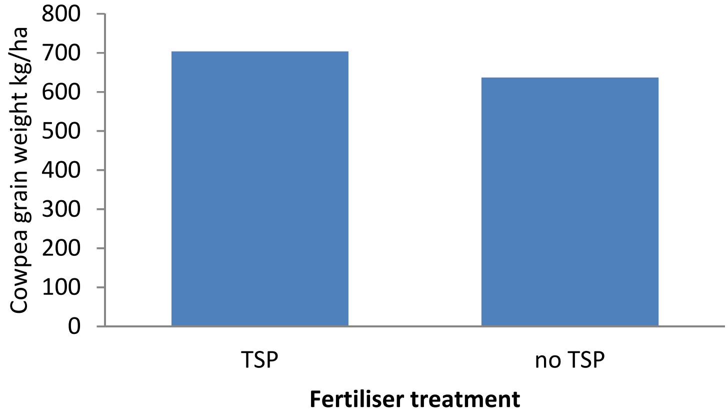

Figure.8. Cowpea average grain weight from fertilizer applied and non fertilizer applied trial plots in Salima

3.5. Bean

The total average grain yield for bean was 437.04 kg/ha; the higher average grain yield (Fig.9) was obtained where TSP was applied compared to where no TSP was applied based on Maluwa variety. For Napilira all sampled plots had TSP applied. The higher average grain yield (Fig.9.) was obtained from trials where Napilira variety was planted compared to Maluwa variety. The difference was significant $t(13) = 3.322$, $p<.05$.

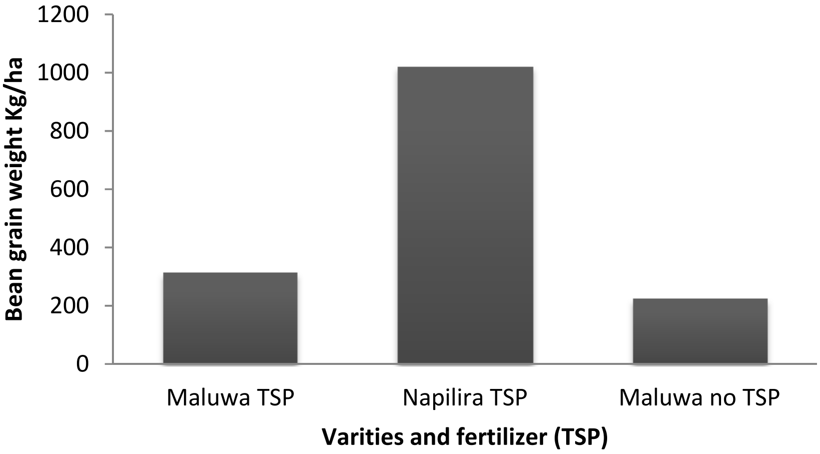

Figure.9. Bean average grain weight kg/ha. Comparing two varieties and both TSP applied and Maluwa non TSP applied trial plots in Mchinji

3.6. Extension service delivery

The delivery of extension services (Table 1) in the two districts varied; in Mchinji 30% of both lead and secondary farmers who participated in the trials received direct advice from the extension workers while in Salima 55% had access to extension services. 59% of farmers in Salima indicated that their trial plots were visited by other famers in the area while in Mchinji it was 49% (Table 1). These were mostly club members being visited by lead farmers not those outside the club membership. The results showed that there was still a gap in extension service delivery in the two districts with some farmers unable to access advice on management of trial plots. Extension workers hinted that the project have failed to fulfill the promises made during project inception as a resulting they have been demoralized. They were promised to be given bicycles (extension workers and lead farmers) for their mobility and lunch allowances (extension workers) whenever they are working on N2Africa activities in the impact area. In Mchinji at the time of the visit; lead farmers indicated that they had last interaction with extension planting and in some cases when they were receiving the trial packages.

Table 1. Extension service delivery per district

	Mchinji				Salima			
	Extension workers		Other Farmers		Extension workers		Other farmers	
	Yes	no	Yes	no	yes	no	Yes	no
Number of farmers	16	37	25	26	24	20	26	18
%	30	70	49	51	55	45	59	41

3.7. Agronomic Practices

The random interviews on agronomic practices showed that in Mchinji farmers applied fertilizer prior to planting while in Salima was done after germination. In terms of planting patterns in Salima most farmers planted soybean in 2 rows on a ridge while in Mchinji was planted in single line on a ridge. The weeding regimes varied among farmers in both districts with an average of 2 times. The inadequate extension advice on management of trial plots was likely to have had an influence on the overall results of the performance of technologies.

4.0. DISCUSSION

The purpose of this study was to evaluate performance of legume technologies being promoted by the N2Africa project in Malawi and assess the differences between the treatments and districts in terms of grain yield. The average grain weight yields varied (Figs.4, 5, 6, 7, 8 and 9) between treatments applied to legumes and between the districts. Soybean + TSP + inoculants gave significantly higher grain yields than soybean + TSP (Fig. 4). The average grain weight yields of Soybean + TSP + inoculants were higher compared to country productivity estimate of 897.2 kg/ha according to the Ministry of Agriculture (IITA 2009). For fertilizer treatments, higher grain yields on average were obtained where fertilizer (TSP) was applied than where no fertilizer was applied for all the crops: soybean, groundnuts, cowpea and bean (Fig.8 and 9), but were not significantly different. The application of P fertilizer to legumes helps in initial vegetative growth which is beneficial for nitrogen fixation in soils with low P availability since biological nitrogen fixation has a high P requirement. In a similar study; Gachimb *et al*.,(2003) in Kenya observed the most vigorous and steady growth on the legumes grown using rhizobium and triple super phosphate (TSP) followed by TSP alone, Rhizobium alone and the farmer practice in that order. High grain yields of cowpeas (1.7 t ha -1) and beans (2.45 t ha -1) respectively, were achieved from treatments inoculated with rhizobium and phosphate fertilizers. This was high compared with farmers practice which had low yields of 0.6 t ha-1 (beans) and 1.1t/ha (cowpeas), respectively. Soybean benefited from biologically fixed nitrogen enhanced by the application of inoculants and P fertilizer in the trial plots. The overall average grain yields were not significantly different between the districts; however Salima had higher grain yields than Mchinji (Figs. 4 and 5). This is because of different biophysical and climatic conditions in the two districts. Salima has soil with higher clay content than Mchinji with a mixture of sandy and red soils (Katondo). Soybeans do well in soils with high clay content than in weak sands (SeedCO Agronomy Manual, undated). The late distribution of inputs and planting might have affected Mchinji more than Salima in terms of soil temperature and amount of rainfall required. Salima experience higher temperature than Mchinji. Farmers' opinions showed that Salima received good amount of rainfall and distributed over a longer period than in the past years. Soybean + TSP + inoculants and soybean + TSP had higher grain yield in Salima than Mchinji but the difference was not significant (Fig. 4). This can possibly be attributed to variations in extension delivery (Table 1) between the two districts which was reflected in farmer management of trial plots differences. In Mchinji farmers applied fertiliser before planting while in Salima they applied after germination. This might have contributed to differences in grain yield beside other factors in the districts. A survey carried out in 2005 in Malawi by Kabuli *et al.*, observed that 30.5% of the soybean adopters had access to extension services but the intensity and quality of the extension services was questionable. Hagmann *et al*., (1998), reported that the integration of grain legumes, such as cowpeas and common bean in integrated nutrient management strategies needs to be supported by well-structured research and extension services aimed at increasing capacity of farmers to be better learners and to rise to new challenges and dynamism in the farming environment. Kabuli *et al.*, (2005), observed that resource poor farmers need to be encouraged through increased information dissemination to adopt and incorporate the soybean and other legume technologies in order for them to maximise returns from their farming. The analysis on inoculants type in Salima showed that average grain yields were not significantly different; however Marondera inoculant gave higher grain yield on average than Chitedze inoculant (Fig. 6). The effectiveness of inoculants differs even within same biophysical conditions. Chianu *et al*. **(**2010) reported that inoculation of legumes with compatible and appropriate rhizobia may be necessary where a low population of native rhizobial strains predominates and is one of the solutions which grain legume farmers can use to optimize yields. Maobe *et al*. (1998) concluded that legume productivity can potentially be improved through the use of appropriate germplasm and the combined application of rhizobium inoculation and inorganic phosphorus Therefore there is need to identify right type of inoculants and soybean varieties suitable to agroecological conditions in the districts where the project is being implemented.

The land allocated to legume production in the two districts was 21% of the available land with groundnuts (63%) taking the largest share in the combined and individual districts (Fig. 1, 2 and 3). This was well above the average annual cultivated area for groundnut, stated to be 27% the total legume land for the period 1991-2006 of (Simtowe *et al.,* undated). Farmers tend to prioritize the crops they grow annually considering the available land. A study by Kabuli *et al.,* 2005 on soybean adoption found that landholding sizes and asset ownership were better for the soybean adopting households than for the non-adopting households. In other words farmers with larger landholdings were more likely to adopt soybean production. Hence it was important to look at farm sizes in the two districts. The production of bean in Mchinji and soybean in Salima was mostly limited to the trial plots. This calls for increased information dissemination on production and utilization methods to support a wider group of farmers.

5.0. CONCLUSIONS

- The use of inoculants, fertilizer and right varieties improved legume production in smallholder farming systems. However the question is whether farmers are ready to apply fertilizer to legumes on expense of crops of social and economic value such as maize and tobacco in absence of stable markets.
- The trials need more technical support in term extension service to have meaningful recommendations drawn from the assessments.
- The implementation of large scale projects seem to be an option to reach more communities however the assessment of partners should include availability of human capital at grassroots for agronomic activities. This seems to be one of the factors which contributed to the differences in technology performance between Mchinji and Salima.

6.0. GENERAL OBSERVATIONS

- It was difficult for farmers to assess the technologies because control plots did not use local seeds. In some cases no control plots were available
- The farmers understanding of concept differed as some looked at it a project giving seed and fames are left with higher expectations of more handouts to come
- While in Salima, extension workers seem to be more connected to farmers where DAES is implementing partner in Mchinji there seem to be a gap. The flow of information has to go through two extension agents (CHDI and DAES) before reaching intended beneficiaries. This might have affected implementation of activities. As evidenced during data collection that farmers were not aware of next step like how to harvest the demonstration plots. This resulted into mixing of yields from 3 trial plots.

7.0. RECOMMENDATIONS

- The partnership with other stakeholders would be more effective if were based on activities than project; for instance all agronomic activities being implemented by DAES, who have extension workers at grassroots rather than other partners who will have to use the same government extension workers after all.
- The partnership with ministry of agriculture could have been at district level rather than Capitol Hill to ensure resources are available to AEDOs at EPA.
- Probably an assessment of human capital of partners would be important to ensure success of the project.
- N2Afrcia staffs need to have frequent monitoring schedules to check progress on the ground and provide technical back up

7.1. Feedback on the practical implementation of the field book

- The field book captured important data from the trials apart from some parameters which farmers were not aware that they should measure during harvest. However it was difficult for farmers to assess the technologies performance (PART F) in relation to their own fields because most of them did not have legume fields of their own especially for soybean, cowpea and beans.
- Due to lack of record keeping farmers had difficulties to recall when they implemented some agronomic practices (Part D). Hence data under cropping calendar is basically in months making it difficult to attribute differences in yield to planting dates.
- Part G (optional) is an important component of the field book but farmers have no records indicating when their fields were visited by extension staff or fellow farmers and advice they got. It would be important to train them in recording major activities on the trial plots in future.
- The sampling of farmers could have been made easier if the individual information for clubs on package received and number of farmers was available before going to the field. The available list during this survey was not very reliable as some names which appeared to have received the package did not receive and had to change the sample in the field.

- The periodic implementation of the field book would help; sampling of farmers to be monitored should be done at the beginning of the season so that data collection can be done in phases based on cropping calendar. This will ensure that reliable information is collected rather than relying on memory recall after 4 months. The implementing partners should take a leading role in implementing the field book.
- Need to capture meteorological data as part of monitoring

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9.0. Appendix

TRIAL PLOT LAYOUT OF LEAD FARMERS

Soybean (Makwacha) + TSP Plot 1	Soybean (local) Plot 2	Soybean (Nasoko) +TSP Plot 3
Soybean (Makwacha) + TSP + inoculant (Marondera) Plot 1	Soybean (local) Plot 2	Soybean (Nasoko) + TSP + inoculant (Chitedze) Plot 3
Bean (Napilira) + TSP Plot 1	Bean (local) Plot 2	Bean (Maluwa) +TSP Plot 3
Cowpea (IT16) + Maize + TSP Plot 1	Cowpea (local) Plot 2	Cowpea + +TSP Plot 3