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ASSESSING ADOPTION POTENTIAL OF NEW GROUNDNUT VARIETIES IN MALAWI

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SUMMARY

Farmers hosted on-farm trials and demonstrations involving three new groundnut (*Arachis hypogaea*) varieties in Malawi to assess their acceptability and adoption potential. Patterns of seed diffusion among trial farmers were examined as well as among non-trial farmers who were members of seed banks. The study showed that trial follow-up surveys provide a cost-effective approach for assessing early adoption and providing feedback to researchers. While useful, however, such studies are not an end in themselves. Rather they need to be perceived and designed as one of several studies that help researchers understand the complexity of farmers' adoption decisions.

INTRODUCTION

Research efforts to develop and disseminate new agricultural technologies frequently involve multi-disciplinary teams of scientists, and activities are typically conducted over several years. Monitoring farmers' perception and obtaining feedback about the performance of new technologies, especially when experiments are conducted on farmers' fields, is therefore necessary for improving the efficiency of research, technology exchange and information flows to policy makers. On-farm research has been used in crop improvement programmes to evaluate and verify performance of new crop varieties on farmers' fields, identify farmers' preferences on varietal traits, quantify the effects of pests and diseases, and identify production and adoption constraints. On-farm research can be used also as a strategic research tool to predict adoption potential by monitoring farmers' opinions or assessing the acceptability of any new technology, as it is being developed and tested.

This paper assesses the acceptability of new groundnut (*Arachis hypogaea*) varieties through follow-up studies with farmers who participated in on-farm trials or demonstrations in Malawi. The objective was to determine whether trial farmers continued using the new groundnut varieties and crop management practices tested on their farms, and to assess the patterns of dissemination of the new varieties among farmers who continued growing them after the trials ended.

Using trial farmers in follow-up studies provides a cost-effective and quick method to assess adoption potential over a range of agro-ecological zones, particularly of open-pollinated crop varieties such as groundnut (David *et al.*, 1997).

Groundnut is the most important legume grown in Malawi in terms of the total production and area under cultivation (Chiyembekeza *et al.*, 1998). The crop provides an important source of food and cash income for smallholder farmers and up till the mid 1990s was a key export crop (Babu *et al.*, 1994; Dzilankhulani *et al.*, 1998). Production and export of the crop has steadily declined since the late 1980s, however, as a result of declining area under production and reduced yields.

The crop varieties examined in this paper emerged from research undertaken by the Southern Africa Development Community /International Crops Research Institute for the Semi-Arid Tropics (SADC/ICRISAT) Groundnut Project, a regional initiative established in southern Africa to address concerns about low groundnut yields and other important production constraints in the region. The principal purpose of the project was to support national groundnut research programmes in the SADC member states through continuous supply of improved germplasm for evaluation and utilization in their breeding programmes and broadening of the pool of genetic resources in the region (Subrahmanyam *et al.*, 1998). Early research efforts focussed on developing improved genetic materials, with priority placed on traits such as high yield potential, early maturity and resistance to diseases of major importance, particularly early leaf spot (*Cercospora arachidcola*) and rosette, a viral disease. In 1996 the focus of the project shifted to technology transfer, emphasizing on-farm evaluation of new varieties and crop management practices through on-farm variety trials and demonstrations, as well as seed production. These activities were meant to introduce farmers to the new groundnut varieties developed in earlier phases of the project, verify their performance under farmers' conditions, and get feedback from farmers about those varieties that best met their needs.

In Malawi several on-farm variety trials, variety demonstrations and diagnostic agronomy trials were implemented starting in 1996. The on-farm variety trials were designed and implemented by the national research and extension staff across a range of agro-ecological conditions in the country. The trials were laid out in a randomized complete block design with each trial replicated four times. Each genotype was planted on four ridges measuring 0.90 m by 6 m. One seed was planted at each planting station (0.15 m apart) on top of the ridges. Variety demonstrations were spatially more diverse being planted over a wider geographical area and involved a larger number of farmers. The demonstrations were planted on five ridges measuring 0.90 m by 5 m. These demonstrations were managed by farmers and were used for farmers' evaluation of the new varieties as well as for seed production. In addition to the variety trials and demonstrations, yield gap and diagnostic agronomy trials were planted on farmers' fields. Both of these trials were jointly planned and implemented by staff of the SADC/ICRISAT Groundnut Project and the national research programme. Yield gaps were demonstrated in farmer-managed trials during the 1996–97 and 1997–98 cropping seasons. Twenty farmers were selected for the trials, four from each of five villages. Four treatments were applied in single replicate trials: farmer-grown variety under farmer agronomy; farmer variety grown under research agronomy; research variety grown under farmer agronomy; research variety grown under recommended research agronomy. On-farm diagnostic trials were conducted during 1997–98 and 1998–99 cropping seasons. Trials were planted on farmers' fields in two Agricultural Development Divisions (ADDs). A split-plot design with 2^4 factorial arrangement of treatments and three replications per site was used. The plot factors were different sowing dates. Sub-plot factors were improved variety, CG 7, and a local variety, Chalimbana; two row widths of 90 cm and 60 cm; and two weeding frequencies, once and twice. Treatments were completely randomized within sub-plots. The project also established seed banks in the villages where the yield gap trials were implemented. The stated objective of the seed bank was to make seeds of the new varieties available to farmers through the development of a sustainable seed multiplication and distribution system at the village level. ICRISAT provided the initial stock of groundnut seed to village committees who subsequently distributed seeds to other farmers. The seed committees issued seeds to farmers on loan with the requirement that after harvest farmers repay 200% in seed.

The study monitored farmers' use of three improved groundnut varieties, CG 7, ICGV-SM 90704 and JL 24, and improved crop management practices. The influence of seed banks, which involved only CG 7, on patterns of diffusion of the variety was also examined. In terms of their botanical classification, CG 7 and ICGV-SM 90704 are Virginia types while JL 24 is a Spanish type. CG 7 has a bunch growth habit with an alternate branching pattern. It is easy to harvest because of its bunch growth habit, it matures at 120–130 d, is drought-tolerant and has red and uniform seed with oil content between 48 and 50%. ICGV-SM 90704 has a spreading bunch growth habit, matures at 120–140 d, is resistant to groundnut rosette disease, and has seeds of tan colour containing 45 to 48% oil. JL 24 is a bunch variety that matures at 90–110 d, is drought-tolerant, has no seed dormancy and has pale tan-coloured seed containing 48% oil. The variety trials and demonstrations had three varieties namely CG7, ICGV-SM 90704 and JL 24 while the yield gap and diagnostic agronomy trials had only CG7. Chalimbana, a Virginia type that is widely grown in Malawi was used as a control for all trials and demonstrations. It has a runner growth habit, matures at 140–150 d and has large seeds of tan colour that contain 45% oil. Average seed yield reported in demonstration plots at 22 sites in the country were 1262 kg ha^{-1} for CG 7, 1260 kg ha^{-1} for ICGV-SM 90704, and 1087 kg ha^{-1} for JL 24. In contrast, average yield for the local control, Chalimbana, was 623 kg ha^{-1} (SADC/ICRISAT, 1998).

MATERIALS AND METHODS

The survey involved farmers who had participated in on-farm trials and demonstrations between the 1996–97 and 1998–99 cropping seasons. Data were

Table 1. Distribution of farmers and tested varieties by agricultural development division.

Variety	Number of farmers	Kasungu (%)	Lilongwe (%)
CG 7	56	61	39
ICGV-SM 90704	40	70	30
JL 24	41	66	34

collected from 59 farmers between July and August 1999 in 16 Extension Planning Areas (EPAs) in Lilongwe and Kasungu ADDs which together account for over 70% of the total area under groundnut production in Malawi (Table 1). The sample of farmers for the survey was drawn from lists of farmers in project records while field extension staff assisted in locating them. All farmers who were interviewed had participated in a trial or demonstration for at least one complete season. Those who participated in the variety trial or demonstration received three new varieties – CG 7, ICGV-SM 90704 and JL 24 – while those in the yield gap and diagnostic agronomy trials received only CG 7. All the farmers in the sample reported growing CG 7, 40 grew ICGV-SM 90704, and 41 grew JL 24. Data were also collected from an additional 53 farmers, who were members of seed banks but had not participated in a trial or demonstration, in order to get better insights of the effects of seed banks on the patterns of diffusion of CG 7.

On average, farmers participated in the trials for two years, and for one year in the demonstrations. Farmers who hosted variety trials and demonstrations received 2 and 1.5 kg seed respectively of each new variety while those in the yield gap and diagnostic agronomy trials received 2 kg CG 7 seed. Using recommended seed rates of 90 kg ha^{-1} for CG 7 and ICGV-SM 90704, and 50 kg ha^{-1} for JL 24, the seeds distributed were sufficient to plant 0.03 hectares of CG 7 in all the trials, 0.03 hectares of ICGV-SM 90704, and 0.04 hectares of JL 24 in the variety trials. In the variety demonstration the quantities of seed distributed were sufficient to plant 0.02 hectares of CG 7 and ICGV-SM 90704, and 0.03 hectares of JL 24.

RESULTS

Data were analysed for 56 farmers who provided complete data. Of these, 34 farmers were in Kasungu ADD and 22 in Lilongwe ADD (Table 2). Across both locations three farmers participated in variety trials, 38 in variety demonstrations, 11 in diagnostic agronomy trials, and four in yield gap trials. Seven farmers who participated in the trials or demonstrations were also members of seed banks.

Farmer characteristics

About 60% of the respondents were male. Among female respondents the majority, 68%, lived in male-headed households while nine percent were *de facto* heads of households with migrant husbands and 23% were *de jure* head of households who were never married or were divorced or widowed. Over half of the respondents in the survey, particularly the male respondents, had at least primary education. In contrast, female farmers were less likely to have been to school with about two-thirds of the female respondents reporting no formal education. The average age of respondents was 43 years with no significant difference in the average age of male and female respondents. The average family size was six members comprising an equal proportion of male and female members.

The average farm size in the survey was 2.5 ha. Farms in Kasungu tended to be larger on average than those in Lilongwe but the difference was not statistically significant. However, male respondents reported significantly larger average farm sizes than did female respondents. Family members constituted the dominant source of farm labour but about 40% of respondents reported hiring temporary labour to supplement their family labour supply.

All respondents cultivated maize (*Zea mays*), the main staple food in the survey area. However, over 40% of the respondents reported that they did not produce enough maize to meet their household requirements for an entire year. Although there was no significant difference in the proportion of farmers in Kasungu and Lilongwe who reported producing adequate maize for a year, a higher proportion of female respondents reported producing inadequate quantities of maize to meet household needs compared with male respondents in both locations. Tobacco (*Nicotiana tabacum*), grown by 79% of all respondents, was a major cash crop in both areas although it was more frequent in Kasungu. On average about 0.46 ha was allocated to tobacco plots with no significant difference across the two locations.

Several factors suggested that the trials and demonstrations were biased towards better-off farmers. Thus the results might not be representative for the farm population in the area. The estimated average farm size of 2.5 ha reported in the survey was about twice the average farm size of 1.5 ha reported in a random survey of households in both locations (Dzilankhulani *et al.*, 1998). Only two percent of respondents in the survey reported producing sufficient maize to meet household requirements for less than three months compared with national estimates of 10%. Such biases might reflect the role of extension staff in selecting farmers for trials and demonstrations. Extension agents selected over 90% of the farmers for participation in the trials and demonstrations.

Patterns of adoption

Two criteria were used to assess patterns of adoption in this study. The first considered whether a farmer continued growing a test variety after the trials ended (David *et al.*, 1997). A second indicator, intended to capture the intensity or extent of adoption, measured the area planted to the new variety after the trials ended. More than half of the respondents in the survey continued growing the new varieties after the end of the on-farm trials and demonstrations (Table 2). Specifically, 80% of trial farmers continued growing CG 7, 63% continued growing ICGV-SM 90704 and 51% continued growing JL 24. This observed

Table 2. Farmers who continued to grow improved groundnut varieties after trial ended.

	CG 7		ICGV-SM 90704		JL 24	
	%	No. of farmers	%	No. of farmers	%	No. of farmers
Kasungu	82	34	64	28	56	27
Lilongwe	77	22	58	12	43	14
Total	80	56	63	40	51	41

pattern adoption with farmers showing a strong preference and higher level of acceptance for CG 7 followed by ICGV-SM 90704 and JL 24 is consistent across both regions. Farmers in variety trials were just as likely to continue growing the new varieties as those in demonstrations indicating that the type of on-farm intervention was not an important determinant in farmer adoption behaviour. A higher proportion of farmers in Kasungu continued growing each of the new varieties compared with Lilongwe but these regional variations were not statistically significant. The pattern of adoption among female respondents was similar to the pattern in the entire sample with female respondents just as likely to continue growing the new groundnut varieties as male respondents.

Dis-aggregating the data by membership in seed banks indicated that all farmers who hosted trials and were members in seed banks continued to grow CG 7. This compares with 78% of farmers who continue to grow the variety but were not members of seed banks. Similarly, 92% of respondents in villages with a seed bank continued to grow CG 7 compared with 72% of those in villages without a seed bank. However, membership in seed banks or the location of a seed bank in a village did not significantly influence the decision to continue growing CG 7. Among farmers who continued growing the new groundnut varieties, the indicative proxy for the intensity of adoption was the comparison of the reported area under the test variety and the area cultivated one-year after the trials ended (Table 3). The data on area cultivated in the trial year indicated that farmers followed the recommended seeding rates for CG 7 but used the higher seeding rates to achieve even higher yields with closely spaced ridges for ICGV-SM 90704 and JL 24 (Chiyembekeza *et al.*, 1998).

The results indicated an increase in the area under all the new groundnut varieties implying increased adoption following the trials. Farmers allocated twice as much land to ICGV-SM 90704 and JL 24 and about three times as much land to CG 7 in the year after the trials ended.

Varietal loss

The survey indicated that farmers stopped growing the new groundnut varieties because of socio-economic, trial-related, and agro-ecological factors that may or may not be specific to a variety (Table 4). Socio-economic factors, particularly consumption of seed stock, were most frequently cited as the most important reason why farmers stopped growing all of the new varieties. In a few cases

Table 3. Comparison of average area of trial varieties grown in trial year and one-year after trial ended.

	CG 7	ICGV-SM 90704	JL 24
Area in trial year (ha)	0.02 (n = 56)	0.01 (n = 40)	0.01 (n = 41)
Area one-year after trial (ha)	0.07 (n = 45)	0.02 (n = 25)	0.02 (n = 21)

Table 4. Reasons given for not continuing with improved varieties after trial ended (% of respondents).

		CG7 (n = 11)	ICGV-SM 90704 (n = 13)	JL24 (n = 15)
Socio-economic		**55**	**46**	**47**
	Ate all seeds	36	31	20
	Plot unattended due to sickness	0	0	0
	Unacceptable seed size	9	0	13
	Concentrated with other crops	9	8	7
	Stolen	0	8	7
Trial-related		**18**	**23**	**13**
	Seeds lost in mixture	0	8	0
	Seeds did not germinate	0	0	7
	Seeds taken by extension/ research staff	9	8	7
	Low yielding	9	8	0
Agro-ecological		**27**	**31**	**40**
	Crop destroyed by drought	9	8	7
	Seeds destroyed by pests	18	23	33

farmers reported dis-adoption of CG 7 (9%) and JL 24 (13%) because of factors related to the characteristic of the variety such as dislike for seed size. Agro-ecological factors were also important in explaining varietal loss for all varieties with damage by pests cited as most likely reason for loss of seed stock.

The results did not suggest any reason to believe that farmers who consumed their seeds were the most food insecure. On the contrary, three out of the four farmers who consumed their seed stocks reported producing sufficient maize for their household requirement. In all these cases seed stocks were consumed because the farmers believed that they could get fresh seed stock from extension staff.

Seed diffusion

The majority of respondents (68%) did not distribute seeds of the new varieties. Table 5 showed that 25% of respondents shared seeds of CG 7 with other farmers, 15% shared JL 24, and 8% shared ICGV-SM 90704. Those respondents who shared seed usually distributed it to about one farmer except in the case of CG 7 where seeds were distributed to an average of three farmers. Seed distribution to any one farmer usually involved small quantities of about 1 kg of ICGV-SM 90704 and JL 24 and 3 kg of CG 7. The data also suggested that, in the few cases

Table 5. Distribution of new groundnut varieties by farmers.

Variety	No. of farmers	Percentage giving out seeds	Number of persons given seeds	Quantity of seeds given per person (kg)
CG7	56	25	3	3.3
ICGV-SM 90704	39	8	1	0.8
JL24	40	15	1	1.1

Table 6. CG 7 seed distribution by farmers (%).

	Trial farmers in seed bank (n = 7)	Trial farmers not in seed bank (n = 49)	All farmers in seed bank (n = 49)	All farmers not in seed bank (n = 63)
Gave out seeds	14	26	43	29
Did not give out seeds	86	74	57	71

where respondents shared seed, distribution started about two or three years after the farmer first grew the variety.

Respondents who were members of seed banks were less likely to distribute CG 7 seeds to other farmers compared with those who were not members of seed banks (Table 6). However, this finding might be due to the small sample size of trial farmers who were also members of seed banks.

Analysis of other farmers who did not participate in the trials but were members of seed banks suggested that seed bank members were more likely to distribute seeds compared with farmers who were not members of seed banks.

Seed distribution tended to be restricted to farmer-to-farmer exchange in the same village (61% of cases) or to a farmer in a neighbouring village (28%). Distribution to relatives in the same village accounted for 33% of cases and to a relative in another village in 11% of cases in which seed was shared.

Among farmers who distributed seeds of the new groundnut varieties about 90% gave the seeds as gifts, particularly to relatives and other farmers with whom they shared close social networks within the village. About one-third of the respondents bartered seeds of the new groundnut varieties for seeds of other crops while about one-fifth sold seeds to other farmers.

The pattern of responses for non-distribution of seeds was consistent for all the three new groundnut varieties. Respondents cited inadequate quantities of seed as the most frequent reason for not distributing seeds (41% of cases for CG 7, 33% of cases for ICGV-SM 90704 and JL 24). About a third of the respondents did not distribute the new groundnut varieties because no one asked them for seeds while another 20% wanted to increase their seed stock.

Most of the respondents (82%) knew where to get fresh seed stock. The extension service was cited as the main source of fresh seeds particularly in villages without seed banks. About 40% of respondents cited other farmers in their village as a source of fresh seed implying that seed banks tended to enhance farmer-to-

Table 7. Median ranking by farmers of new groundnut varieties and local variety (n = 37).

Trait	CG 7	ICGV-SM 90704	JL 24	Local variety (Chalimbana)
Good taste	1	3	2	4
Cooks fast	1	3	2	4
Big seed size	2	3	4	1
Sell easily	2	3	3	1
Early maturing	2	2	1	4
High yielding	1	3	2	4
Tolerant to insect pest	2	3	2	2
Disease resistant	2	2	3	4
Does well under drought conditions	1	2	2	4
Overall ranking	1	3	2	4

Ranking is from 1 (best) to 4 (poorest)

farmer seed exchange in the villages where they were located. Very few farmers (2%), cited seed banks outside their village as a source of fresh seed. This suggested that seed banks played a limited role in enhancing seed diffusion outside the villages in which they were located.

Farmers' perception of the improved varieties

The survey collected data on farmers' perception of the three new varieties and control over a range of crop traits. Median ranking of farmers' overall preference indicated that CG 7 was the most preferred variety followed by JL 24 and ICGV-SM 90704 (Table 7). Farmers also preferred all the new varieties to Chalimbana, the local control. In terms of individual ranking of traits, CG 7 was highly preferred because of its high yield, taste, cooking time and drought tolerance while JL 24 was rated highly because of its early maturity.

Kendall's W test was used to further discriminate farmers' preference ranking where the result from the median test was not conclusive. This result indicated that CG 7 was ranked higher than ICGV-SM 90704 on early maturity while JL 24 was ranked higher than ICGV-SM 90704 on drought tolerance.

DISCUSSION

The results from this study suggested a high level of acceptability of the improved groundnut varieties among farmers who were exposed to them in on-farm variety trials and demonstrations. The study also implied differential patterns of adoption between the three varieties. Across all regions CG 7 demonstrated the highest level of acceptance and potential for adoption followed by ICGV-SM 90704 and JL 24. The lack of significant differences in adoption behaviour between male and female farmers suggested that the women were just as likely to adopt the new groundnut varieties as were their male counterparts. A likely explanation for this is that the new technologies were consistent with women farmers' resource level and met their technology needs. It is likely that the observed differences in adoption patterns reflected farmers' appreciation of the characteristics of CG 7 compared with ICGV-90704 and JL 24. It is equally plausible, however, that the differences in adoption patterns was a reflection of farmers' familiarity with CG 7, having being exposed to it for a much longer period through the activities of other development agencies in Malawi. Farmers might also have underestimated the performance of the other groundnut varieties because they only demonstrated superior performance under specific conditions. For example, since the incidence of rosette was low during the years of testing, farmers were likely to underestimate the yield performance of the rosette-resistant variety ICGV-SM 90704. In years when there were outbreaks of rosette (such as in 1994–95 and 1999–2000) ICGV-SM 90704 consistently out yielded CG 7 and JL 24.

Farmers stopped growing the new groundnut varieties for several reasons. Some consumed their seed stock, even of preferred varieties, because they were under pressure to satisfy their subsistence needs. Others who were not necessarily food-insecure consumed their seed stocks because they perceived that they could get fresh supplies from extension services. In other cases farmers stopped growing the new groundnut varieties because of reasons related to the characteristics of the varieties, while some had difficulties maintaining their seed stock because of drought and pests. This assortment of reasons for not continuing to grow the improved groundnut varieties points to the complexity of factors, often working simultaneously, that underlie farmers' adoption decisions. Adoption studies that will be useful for research planning need to recognize these complex interactions as well as their influence in conditioning farmers' adoption decisions.

Informal farmer-to-farmer diffusion was the main distribution mechanism for disseminating seeds of the new groundnut varieties. This process, however, had a considerable time lag, involved small quantities of seed, and was limited to farmers within close social networks. This finding is consistent with other studies in Africa and suggests that the nature of informal seed networks and the dynamics of farmer-to-farmer seed diffusion may not necessarily facilitate rapid dissemination of new crop varieties (David and Sperling, 1999). These concerns are even more relevant for groundnut because its low multiplication factor and high seeding rate imply that large seed stocks are required to enable farmers to keep seeds of preferred varieties in their portfolio of varieties.

The lack of a significant relationship between membership of a seed bank and the decision to continue growing CG 7 suggested that this institutional innovation might have had a negligible influence on the dissemination of the improved groundnut variety. This finding, however, might be due to the small sample of farmers who both hosted trials and were members of seed banks. Nonetheless the results for the entire sample suggest that, within villages in which they were located, the seed banks reduced the search and negotiation costs for acquiring seeds of the new varieties. As a result the seed banks increased the number of farmers who were able to grow the new groundnut varieties, expanded the diversity of farmers' portfolio of groundnut varieties, and in some cases improved seed security.

The study implied, however, that community-based interventions, such as the seed banks, that rely on farmer-to-farmer diffusion need to broaden their initial injection of seed into informal seed networks so that they can take full advantage of getting seeds into the hands of as many farmers as possible. Efforts to speed diffusion of preferred varieties also need to exploit alternative market and non-market seed distribution mechanisms to ensure that seed is always available and is available to everyone with an effective demand.

Farmers' assessment of the new varieties early in the research process provides useful feedback on farmers' priorities as well as problems with the new technologies. Such information is useful in refining technology development efforts and improving the two-way flow of information between researchers and farmers.

CONCLUSION

Follow-up studies with farmers who have been exposed to new varieties in on-farm trials and demonstrations provide a cost-effective approach to assessing the acceptability and adoption potential of new varieties. However, such studies should be designed as one of several studies that provide early assessment of farmer adoption decisions. In the medium term, after the new varieties have been disseminated in the wider farming population, it will be necessary to conduct formal surveys of technology adoption with larger samples. Such studies offer useful insights into the complex factors influencing farmers' adoption decisions and provide useful feedback to researchers and policy makers.

REFERENCES

Babu, S. C., Subrahmanyam, P., Chiyembekeza A. J. and Ng'ong'ola, D. (1994). Impact of aflatoxin contamination on groundnut exports in Malawi. *African Crop Science Journal* 2:215–220.

Chiyembekeza, A. J., Subrahmanyam, P., Kisyombe, C. T. and Nyirenda, N. E. (1998). *Groundnut: a package of recommendations for production in Malawi*. Lilongwe: Ministry of Agriculture and Irrigation.

David S., Wortmann, C., Kasozi, S. and Mugisha-Muteikka, M. (1997). Using trial follow-up surveys to assess varietal adoption: The case of beans. *African Crop Science Journal* 5 (3):285–294

David, S. and Sperling, L. (1999). Improving technology delivery mechanisms: Lessons from bean seed systems research in eastern and central Africa. *Agriculture and Human Values* 16:381–338.

Dzilankhulani, A. M., Tchale, H. and Boughton, D. (1998). Small-scale seed programs and adoption of groundnut technology: The case of CG 7 groundnut variety in Malawi. *Unpublished report, International Crops Research Institute for the Semi-Arid Tropics, Lilongwe, Malawi.*