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The effectiveness and complementarity of field days and small seed packs (SSPs) in delivering Dryland Cereal technologies:

A survey of field day participants and agro-vets in Singida and Iramba districts of central Tanzania

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Henry Ojulong and Eric Manyasa

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International Crops Research Institute for the Semi-Arid Tropics

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This work has been undertaken as part of the CGIAR Research Program on Dryland Cereals

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2015

Abstract

This paper is about the result of a survey done in the 2014-2015 cropping season of field day participants and agro-vets who were facilitated to market SSPs and SFPs in Singida and Iramba districts of Tanzania. The objective of the survey was to determine whether there was any correlation between awareness creation and preferences reported during field days and the demand for technological inputs from the agro-vets. The results showed a strong complementarity between the dissemination of information on improved technologies during field days and the retailing of SSPs and SFPs in agro-vets. The field days help in creating awareness about the benefits and attributes of available improved sorghum and finger millet varieties and associated agronomic recommendations; while retailing of the SSPs and SFPs by the agro-vets not only helps promote the demand for improved technological inputs but also enhances their accessibility as SSPs and SFPs are more affordable to resource poor farmers. Therefore, having field days for awareness creation without improving accessibility of technological inputs through sale of SSPs and SFPs or vice versa is futile and does not lead to enhanced experimentation and adoption of improved technologies by target farmers.

A large proportion (80%) of the surveyed field day participants reported having attended at least one field day previously. The mean number of field days attended was 2.2; and there was a strong positive correlation between number of field days attended and application of R4D technologies by the farmers - repeat attendance reinforced learning and experimentation of available improved varieties. A greater proportion of field day participants (73%) walked > 5km to reach agro-vets retailing SSPs, compared to only 37% who travelled > 5km to reach field day sites for information on improved crop varieties and associated agronomic practices. Using distances travelled as a proxy to accessibility, information on improved varieties was more accessible to project farmers than SSPs were. Therefore scaling up to increase the number of agro-dealers selling SSPs is necessary.

During the field days, the greatest awareness created, in descending order of importance, was information on variety (36%), row planting (22%) and seed selection (14%). The field days were weakest in imparting information on grain marketing (2%), disease control (3%), weed control (3%), postharvest handling (3%) and soil fertility management (4%). Satisfaction with application of technologies was high (90% of responses) as the application of suitable variety, micro-dosing and row planting was estimated to augment yield by 15 bags (90 kg/bag) and 10 bags per ha, respectively, in sorghum and millets.

In Singida, the demand for SSPs of all available improved varieties of sorghum (Macia and NACO) and finger millet (U15 and P224) was high as >75% of the SSPs were purchased by farmers. In Iramba, however, while the demand for P224 and Macia was high (> 75% SSPs were purchased), the demand for U15 and NACO was low as <25% of the available SSPs were purchased. Therefore, QDS production and marketing in Singida should focus on all four improved varieties (Macia, NACO, U15 & P224) while in Iramba QDS production and marketing should concentrate on production and marketing SSPs of P224 and Macia. The low demand for U15 and NACO in Iramba district should be investigated further.

The main sources of information for SSPs were field days (45%) and other farmers (33%) while the main source of information on fertilizer use and benefits was other farmers (66%) and field days were a distant second at 21%. The agro-vet survey study also revealed that women preferred SFPs of DAP while men preferred SFPs of urea and that the most preferred SFP size was 1 kg. Fertilizer use on various crops was variable as out of the purchased SFPs, nil was used on finger millet, 10% on sorghum, 20% on maize and 70% on vegetable production. Therefore there should be a greater focus in demonstrating the benefits of fertilizer use in sorghum and finger millet production during farmers' field days in addition to undertaking TOTs to promote fertilizer use and general soil a water and fertility management.

Key words: SSPs, SFPs, field day, agro-vets, improved varieties, technological inputs, sorghum, finger millet, QDS, Macia, NACO, U15, P224, seed, agronomy, information, access, preferences, survey, dissemination, awareness, learning, experimentation and adoption.

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Executive summary

Although an efficient R4D technology dissemination channel is a necessary step to enhance adoption of improved R4D technologies, it is not a sufficient condition for adoption. The reason is that although information on the use and benefits of the technologies may be sufficiently communicated to target farmers for improved production, inefficiencies in the technological input supply chain may hamper the demand for and accessibility to these improved technologies. Therefore, the Dryland Cereals program of ICRISAT through the Harnessing Opportunities for Productivity Enhancement (HOPE) and Sorghum for Multiuse (SMU) projects implemented participatory variety selection (PVS) and field day activities to create awareness on the availability, use and benefits of improved sorghum and finger millet varieties and associated improved agronomic practices. Consequently, to improve the accessibility of technological inputs, the projects at the same time facilitated retailing of Small Seed Packs (SSPs) and Small Fertilizer Packs (SFPs) from agro-vets in the projects' mandate districts. This was done to promote accessibility and test the demand for the technological inputs that the farmers were introduced to during PVS and field days.

This study was undertaken to establish whether there were any synergies between field days and PVS on the one hand and the sale of SSPs and SFPs on the other. In other words was there any correlation between information availed during field days and the demand for technological inputs (SSPs and SFPs) from the agro-vets? A semi-structured questionnaire was used to collect data from a random sample of field day participants to ascertain the level of effectiveness of the field days. Immediately after the field days, a forum, of farmers who produce quality declared seed (QDS), and agro-vets was organized to draw an action plan that included the roles of stakeholders in the sale of the preferred improved sorghum and finger millet varieties (SSPs) and preferred fertilizer types and in the size of packages. Profit margins for farmers producing QDS and for agro-vets marketing SSPs was agreed upon during the forum. Two agro-vets in each mandate district were selected, facilitated to stock SSPs and SFPs and trained to administer a semi-structured questionnaire to collect feedback from farmers who visited the agro-vets to purchase SSPs and SFPs. The collected data was analyzed with SPSS for descriptive statistics. ANOVA and Chi-square tests were used to detect any significant differences between males and females and between other variables included in the study.

Of the field day attendees interviewed, 63% in Iramba and 96% in Singida reported having attended previous field days - indicating a high proportion of repeat attendees. A greater proportion of females as compared to males of the sampled field day participants had previously attended at least one field day while the mean number of field days previously attended was not significantly different between female and male participants and also between the two districts. This is an indication that the field days were as accessible to women as they were to men. Overall the female field day attendees were 11 years younger than their male counterparts. Further analysis showed that a greater proportion of male attendees (48%) as compared to female attendees (20%) travelled > 5km to attend field days. This means that male farmers were more likely to travel longer distances to field days than female farmers. This contradicts an earlier finding in western Kenya which indicated that women farmers were more likely to travel longer distances to field days than male farmers. This is perhaps due to cultural and religious differences between central Tanzania and western Kenya. Christianity is more predominant in western Tanzania. Nevertheless, it is recommended that the closer the field days are (<5km) to farmers the more accessible they will be to women farmers in central Tanzania.

During the field days the greatest awareness, in descending order of importance, was information on variety, row planting and seed selection. The field days were weakest in imparting information on grain marketing, value addition, disease control, weed control, postharvest handling and soil fertility management. Nevertheless the level of awareness on various technologies did not vary significantly between females and males although a greater proportion of women as compared to men reported that they had received information on weeding. This is, perhaps a reflection of a male dominated society which leaves the more

back breaking farm chores to women. Mechanization or less labor intensive weeding methods would reduce the drudgery faced by women in weeding. In terms of awareness on package recommendations, a significant proportion of farmers in Iramba (92%) as compared to the proportion in Singida (58%) were made aware of the technologies as a package but there was no significant variation between males and females. The most important information received during field days on package technological recommendation was that on variety and row planting (47%) and the least important was that on variety and fertilizer (6%) and variety and weed control (6%). In HOPE Phase 2 as well as in the ongoing SMU activities, there should be greater emphasis on crop agronomy especially soil a water and fertility improvement, weed management (including striga control), diseases and pest management, intercropping systems and postharvest handling. This calls for the fulltime involvement of an agronomist from the National partner and collaboration from ICRISAT.

The other interesting finding was that farmers who had attended a higher number of field days were more likely to practice what they had learned from the field days: that is, repeated attendance of field days increased the chance of learning and practicing what had been learned. Field day participants were asked to state their satisfaction with the use and benefits of the new technologies that they were made aware of during field days. An overwhelming majority (92%) reported in the affirmative and there was no significant difference between sites or gender of farmer. The technology package rated to give the highest additional yield to farmers was variety, row planting and fertilizer use which resulted in eight and six additional bags per hectare, respectively, for sorghum and finger millet; this was followed by variety and row planting at five and three additional bags per hectare for sorghum and finger millet, respectively. Given that PVS and field days will continue, the best bet for further sorghum and finger millet productivity enhancement lies with soil a water and fertility management as well as improved weed, pest and disease management interventions.

The main sorghum production constraints in Iramba and Singida were bird damage, pests and diseases and drought. While for men the key constraints were bird damage, pests and diseases and drought, for women they were bird damage, pests and diseases and lack of money to buy fertilizers. Finger millet production constraints were prioritized as drought, lack of quality seed and markets in Iramba while in Singida they were drought, lack of weeding labor as well as diseases and pests. For men the key finger millet constraints were drought, lack of markets and late planting due lack of land preparation equipment, while for women the priority constraints were drought, lack of quality seeds, lack of labor for weeding and lack of capital to buy fertilizers. In summary, for finger millet the most important production constraints were drought and lack of quality seed while for sorghum they were bird damage and pests and diseases. Asked on ways to improve future field days the responses were: make field days more frequent and with more training interventions; improve access to technological inputs - availability, quality and affordability in time and space; improve market linkage; motivate more farmers to attend; and inform farmers well in advance about the field day.

Although the record from field days in central Tanzania show that about as many women as men attended field days, of the farmers who bought SSPs only 25% were female while only 19% of those who purchased SFPs were women. The conclusion is that although almost half of the farmers who received information on the use and benefits of improved technologies during farmers' field days were women, women formed less than one fourth of the farmers accessing physical inputs from the agro-vets. This points to a serious constraint limiting women from accessing technological inputs: perhaps unaffordability of the technological inputs and/or high cost of travelling to agro-vets. This confirms the finding in western Kenya which indicated that more women than men were constrained in accessing fertilizer for finger millet production.

The study also revealed that farmers who purchased SFPs were significantly younger than those who purchased SSPs. Younger farmers are more likely to purchase and use fertilizers than the older ones while there was no significant age difference in the demand for SSPs.

While the distance travelled by farmers to agro-vets did not vary significantly by gender, farmers travelled significantly (p = 0.000) longer distances to purchase SSPs than to purchase SFPs. Farmers were willing to travel longer distances for seed but not for fertilizer. Fertilizers are complimentary inputs to improved varieties and, therefore, to make fertilizers more accessible to smallholder farmers, the retail outlets (agro-vets) need to operate close (within five km) to potential users. Farmers in Singida travelled significantly longer distances to buy SSPs and SFPs than farmers in Iramba. Singida agro-vets that stocked SSPs and SFPs were far from the farmers. Sensitization and scaling up should be done to involve more agro-vets in marketing SSPs of QDS in order to improve the accessibility of physical inputs.

Comparing distance travelled to the source of information for improved varieties and agronomic practices with distance travelled to buy SSPs, shows that only 37% of the field day participants travelled more than five km to seek information from the field day sites while a whopping 73% of the farmers who purchased SSPs had travelled more than five km. Therefore although information on variety and management practice is relatively accessible during field days, trial and adoption is constrained by the inaccessibility of improved seeds. Generally there was no variation between female and male farmers. This means that access to information on variety and management practices was far easier for farmers than access to seeds of improved varieties of sorghum and finger millet in terms of cost of travel.

Two methods were used to determine demand and preference for improved varieties by farmers:

- Quantity of seed of available SSPs of improved varieties sold by the agro-vets, and
- Proportion of farmers purchasing the available SSPs of improved seed from the agro-vets.

In terms of quantity sold by the agro-vets, there was a high demand for SSPs of all improved varieties of sorghum and finger millet in Singida as about three fourth of the seed supplied was sold. In Iramba, the demand for SSPs of Macia sorghum and P224 finger millet was very high, as 75 and 100%, respectively was sold. However, the demand for SSPs of NACO sorghum and U15 finger millet was low as less than one fourth of the available seed was sold. Based on these figures this study recommends that:

- Singida farmers should focus on the production and marketing of QDS of SSPs of NACO, Macia, U15 and P224
- Iramba farmers should limit themselves to production and marketing of QDS of SSPs of Macia sorghum and P224 finger millet, while FDGs should investigate why the demand/preference for NACO and U15 is very low.

Although Macia was released in 1999, SSP purchases showed that NACO (released in 2013) was as popular as Macia, especially in Singida. In Singida significantly more female (41%) as compared to male (33%) farmers preferred NACO. The apparent preference by women for NACO in Singida is its positive attribute in making very good *ugali* - an important local dish in the east African region. One concludes that: a) the field days were very effective in disseminating information on agronomic and end use attributes of NACO in Singida and the farmers, especially women, appreciate the agronomic and end-use attributes of NACO, and b) the participation of women farmers during field days and PVS was satisfactory or, the field days were quite effective in reaching women farmers. No finger millet variety had been released prior to 2013, when P224 and U15 were released. In Iramba, P224 (14%) finger millet was significantly more popular than U15 (7%), while in Singida there was no significant difference in preference between P224 (12%) and U15 (11%).

Of the buyers of SSPs of improved varieties, 74% had never planted the varieties prior to buying SSPs in the 2014-15 season and only 26% of the buyers of SSPs of improved varieties from the selected agro-vets had used the varieties prior to purchase of SSPs. This proves that SSPs in agro-vets is a good seed delivery channel to promote the use and demand for improved crop varieties. The main communication channels for buyers of

SSPs of improved varieties were through seeing (69%) and through hearing (22%) while 9% of the buyers of SSPs of improved varieties had neither seen nor heard about them. There was a strong correlation between seeing and buying of SSPs of improved varieties from the agro-vets and this is confirmed by the main sources of varietal information reported by farmers: the field days/or farmer field schools (45%) and neighbors farms (33%). On the other hand the main sources of information on fertilizer use were: other farmers (66%) and field days (21%) Therefore, while the field days were quite effective in disseminating varietal information or creating awareness about their availability and potential benefits, they were not as effective in disseminating information on fertilizer use and benefits. It is therefore recommended that the fertilizer use demos in field days should be made more effective and training of trainers (TOTs) should be used more to promote fertilizer use. Furthermore, the farmers who had seen the new varieties prior to purchase of SSPs, bought significantly more SSPs than those who had neither seen nor heard about them. Physically seeing the technologies, their use and potential benefits improves the confidence of farmers in the technologies and increases the likelihood of trial and adoption and therefore the demand for seed. Promoting the demand for seed of improved varieties through field days and demos is critical for improving the demand for seed and adoption. A similar study from western Kenya indicates that it is futile to stock agro-vets with SSPs of improved varieties without giving farmers prior exposure through PVS and field days.

The improved sorghum, finger millet and fertilizer demand curves (gauged by when farmers first used the improved technologies) over time indicate a strong positive correlation between the intensity of technology dissemination activities (undertaken in HOPE and SMU projects in 2010-2014) and the demand for improved technologies. Implementation of activities that enhance learning or lead to awareness creation about the use and benefits of new technologies promote experimentation by farmers and enhance the demand for technological inputs from agro-vets. Comparing the trend in the demand curves for year of first use of improved varieties as well as the year of first use of fertilizer shows a similar trend for both the demand curve for improved sorghum and millet varieties and the fertilizer demand curve over the same period. One concludes there was some level of awareness creation for package recommendations (variety and fertilizer) that sparked the demand for both variety and fertilizer from the agro-dealers.

Women preferred DAP based SFPs compared to men who had a higher preference for urea based SFPs. The reason why men prefer fertilizer for top-dressing sorghum and millets (urea) while women prefer fertilizer used at the time of planting (DAP), is not clear but what is obvious is that using DAP is more labor intensive than using urea. The most preferred SFP size is 1 kg followed by 5 kg, for both men and women farmers and the reason for this is mainly affordability. Therefore the 1 kg SFP size should be encouraged as it enhances fertilizer accessibility to resource-poor farmers.

Fertilizer application in sorghum production was minimal as only 10% of the SFPs purchased were applied to sorghum and compared to maize (19%) and vegetables (69%). Nevertheless, for those who purchased SSPs to use on sorghum, the fertilizer application rate on sorghum was comparable to the micro-dosing rates recommended in the HOPE and SMU projects (50 kg ha^{-1} of DAP and 40 kg ha^{-1} of urea).

Finally, the majority (70%) of the SSPs buyers were satisfied with the performance of the improved varieties and there was no variation in satisfaction between men and women farmers. Although about half of the farmers who had used fertilizer on sorghum were very satisfied with the outcome, as compared to those who had used fertilizer on vegetables, a greater proportion (about 90%) was very satisfied with the outcome. The main reasons for dissatisfaction with improved varieties of sorghum and finger millet were late planting due to lack of land preparation equipment (41%), pests and diseases (24%), poor yield especially Macia (12%) and poor germination especially Macia (9%). There were two main reasons for dissatisfaction with the performance of fertilizer: drought (61%) and unaffordability (27%).

Background and rationale

Many technology dissemination or delivery methodologies have laid emphasis on technological package recommendations of crop varieties in combination with other agronomic practices such as fertilizer application to improve productivity and drive the demand for and adoption of improved technologies. This is mainly because past studies have shown that improved crop varieties enable farmers to improve farm productivity only when used in combination with improved soil water and fertility management, as was the case with the green revolution in India (FAO 1996). The premise is that given adequate information on the use and profitability of complementary technologies such as variety and fertilizer use, the demand for these inputs should increase proportionately and thereby improve adoption (Kelsey 2013). That is, farmers will be more motivated to acquire the technologies when they have understood their use as well as the fact that the benefits are much more when the technologies are used together.

However, adequate information on technology use and profitability, though necessary, is not a sufficient condition for increased demand for and adoption of improved R4D technologies. This is because input market inefficiencies may prevent farmers' access to the recommended technological inputs (Kelsey 2013). Some of the reasons that may limit smallholder farmers' accessibility to recommended technology inputs in the input market include: unaffordability, timely availability and proximity of the input source to farm households (Aloyce et al. 2014, Salami et al. 2010 and Gordon 2000).

Conceptually, adoption of technologies is a three step process of learning/awareness, trial/evaluation and adoption. The adoption and effectiveness of a given dissemination strategy depends on:

- Characteristics of the innovation and the level of overlap with the production objectives of the target audience which would be reflected in farmer preferences
- The type of information channel in use and its effectiveness in making farmers learn about how to apply modern technologies and about their potential benefits relative to the old technologies
- The strength of the link between the learning or awareness phase and technological input acquisition phase

The communication channel aids the learning process on new innovations and this in turn enhances trial, evaluation and uptake. The effectiveness of the communication channel can therefore be estimated by capturing farmer feedback at the learning phase. The willingness to try new technologies can be estimated by tracking the demand for new technological inputs which would be reflected by the purchase of these inputs at the agro-vet or retail level.

ICRISAT's Dryland Cereals Research in ESA, through the HOPE and SMU projects, has directed its efforts to improve the accessibility of information, seed and fertilizer to smallholder resource poor farmers through various technology delivery channels, including partnership with input market outlets (agro-vets). For one, the project stakeholders' consultative meeting held before implementation of each project undertook rapid situational analysis where needs and priorities were identified and assessed within the context of varying technological recommendation domains or clusters, and recommended improved varieties and agronomic practices. In addition, participatory variety selection (PVS) and soil fertility trials were planned and conducted in project mandate districts in Tanzania with active farmer participation to identify and select their variety and agronomic practice preferences based on household and market objectives. Field days for PVS as well as for communicating to farmers and input suppliers on how to employ the best bet options (variety and agronomic practices) to improve productivity, incomes and food security, were organized during each cropping season from 2010 to 2015. In the two districts included in this study it was estimated that about 4,000 farmers (about 50% women) participated in the field days between the 2010-2011 and 2014-2015 cropping seasons. Variation in gender learning and preferences was also captured during these field days.

On the basis of feedback during farmer and input supplier consultations, the input suppliers got to know the needs of farmers and farmers got to know the location of the agro-vets from which to purchase the input requirements. It was also agreed that, to improve affordability for resource poor farmers, the agro-vets would sell small seed packs (SSP) of finger millet (0.5 kg) and sorghum (1 kg); and small fertilizer packs (SFP) of 1 kg and 5 kg. The sale of SSPs and SFPs through agro-vets is a good way to promote improved technological inputs. The sale of SSPs is also: i) a novel way to strengthen the informal seed system (which is used by 80% of the smallholders) by supplying high quality seed of crop varieties preferred by end users in affordable size packs; ii) an innovative pathway to commercialize quality declared seed (QDS) and any seed of released and promising improved varieties produced by community based seed producers and; iii) an affordable source of seed for resource-constrained farmers.

This paper discusses the effectiveness of field days in promoting the learning of and demand for technological package recommendations of inputs. It sets to answer the following research questions:

- Did the field days impart knowledge on the need for package recommendations?
- Did the knowledge translate into a demand for technological inputs?
- Did perceived farmer preferences correlate with the demand for technological inputs?
- Was there variation according to gender with respect to learning of and demand and preferences for technological inputs?
- Were there any gender differences in challenges and opportunities?
- What are the implications for the future?

Objectives

The main objectives of this paper are:

- To determine the level of effectiveness of farmer field days and their implication for future field days
- To establish farmer variety and agronomic management preferences during field days and from agro-vets
- To establish any correlation between perceived farmers preferences recorded during field days and the demand for technological inputs at agro-vets
- To determine whether learning about variety and fertilizer technological inputs and the demand for them was correlated.

Materials and Methods

PVS for improved sorghum and finger millet varieties and micro-dosing fertilizer trials were undertaken in various technology dissemination clusters in the project mandate districts of Tanzania. Field days for farmers and input suppliers were organized in each cropping season at the physiological maturity period of the crop. The purpose of the field days was to enable farmers to identify crop variety and agronomic preferences based on household level and market objectives as well as to identify challenges and opportunities for future action. A random sample of 25 farmers each were selected from field days held in Iramba and Singida, respectively, and a questionnaire was administered by trained enumerators to capture farmers' feedback. During field days, farmer and input supplier fora were organized to agree on the types of crop variety seeds, fertilizers and the size of mini-packs to be stocked by the agro-dealers.

In order to improve seed supply and gauge the demand (See annex 1), farmer group seed producers were facilitated (by providing high quality foundation seed and subsidizing the cost of seed treatment and packaging) to produce and market high quality seed. The seed was then bought back by the project at market price (cost of production plus 15% margin). It was then supplied to two selected agro-vets each in

Singida and Iramba Districts of Tanzania to enable them to sell SSPs at market price (cost of seed plus 20% margin for the agro-dealer). The agro-dealers were also facilitated (they were paid the cost of packaging) to sell SFPs at market prices. One page questionnaires one each for SSP and SFP, were given to agro-dealers to administer to farmers who bought the SSP and SFP on a voluntary basis. SPSS was used for data entry, analysis and for reporting the descriptive results. For categorical variables, the chi-square test of association was used to check for any significant differences ($p<0.1$) between groups while for quantitative variables ANOVA was used to test for significant ($p<0.1$) differences in the means between groups.

Results and discussions

Farmer field days

Characteristics of field day participants

During the last week of May 2015, one field day each was held in Nkungi village of Iramba District and Ngamu village of Singida District, which 100 and 150 farmers respectively, attended. During the two field days when interviews were conducted, the participation by women was 48% and 52%, respectively. From the field day participants, a random number of 50 farmers was selected and a semi-structured questionnaire was administered by enumerators. Some characteristics of the field day participants are in Table 1. A greater proportion of females as compared to males of the sampled field day participants had previously attended at least one field day, although this difference was not statistically significant. The mean number of field days previously attended was not significantly different between female and male participants and between the two districts. While there was no significant age difference between male and female participants in Iramba, and between the two districts, the female field day participants in Singida were significantly younger than their male counterparts. Overall, the female field day attendees were 11 years younger than their male counterparts.

Effectiveness of farmer field days

Distance to field day sites

Attendance of previous field days by farmers was high. In both Iramba and Singida, 63% and 96% of field day participants, respectively, reported having attended previous field days on improved varietal and agronomic demonstrations (Table 1).

Field days are a means of easing access to varietal and agronomic information for farmers and the distance farmers have to travel to reach field day sites determines the number of participating farmers. Therefore, the distance farmers have to travel to field days is a proxy for ease of accessing the information. At the same time during the field days, farmers are enabled to undertake participatory variety selection (PVS) and selection of preferred management practices that are suitable and beneficial for boosting productivity of selected varieties. Participatory selection of technologies by farmers makes the farmers own the new technologies and increases the probability of trial and adoption. Generally one expects that the closer the field day sites are to farm households (< 5kms), the greater is the number of farmers who are able to attend and participate in them. A higher proportion of male field day participants (63%) in Iramba reported walking significantly longer distances (> 5 km) as compared to women (13%) to field day sites (Table 2). One can say that men were more likely to travel longer distances to field days than women. This contradicts an earlier finding in western Kenya where women were more likely to travel longer distances to field days than men. This is perhaps due to differences in culture and religion between central Tanzania and western Kenya. Therefore, for greater participation of women in PVS and demonstrations during field days, these should be located 5 km or less from the potential target group. In Singida, 31% of the male farmers and 25% of the female farmers travelled more than 5 km to the field day site and the proportions were not significantly different.

Table 1. Some characteristics of field day participants in Iramba and Singida districts of central Tanzania

District /Gender	Characteristics of sampled field day participants (N=50)		
	Percentage of participants reporting attendance to previous field days	Mean no of field days attended	Age (years)
Iramba:			
Female	75	2.1	47
Male	56	2.8	49
Total	63	2.5	48
Singida:			
Female	100	1.9	38
Male	92	2.1	57
Total	96	2.0	48
Total Gender:			
Female	90	2.0	41
Male	72	2.4	52
Total	80	2.2	49

Source: Survey of field day participants in Nkungi village, Iramba and Ngamu village, Singida in May 2015.

Table 2. The distance field day participants travel to field day sites in Iramba and Singida districts of Tanzania

District/Gender	% reporting walking > 5 km to field day sites	Probability level (ns = not significant)
Iramba		
Male	63	
Female	13	0.03
Total	46	
Singida		
Male	31	
Female	25	ns
Total	28	
Gender		
Male	48	
Female	20	0.04
Total	37	

Source: Survey of field day participants in Nkungi and Ngamu villages, 2015

Dissemination of information on individual sorghum and millet technologies

The first step in the adoption process is to be made aware of or to learn about the benefits of and how to apply the information given on the new technologies. Farmers who had attended previous field days were asked what key information on sorghum and millet technologies they had accessed or learned about and the responses are in Table 3. The most important information on sorghum and finger millet technologies that farmers learned from previous field days were suitable varieties, row planting and seed selection. These technologies show the greatest adoption potential by farmers who had participated in previous field days. However, information on improved fertilizer application, postharvest handling, weed control, disease control, value addition and grain marketing was poorly learned by field day participants and needs greater focus in the future. While 10% of the responses recorded in Iramba were information on fertilizer and manure application, no response on fertilizer and manure use was recorded in Singida. This calls for a greater effort to demonstrate the benefits of fertilizer and manure use in Singida. Similarly while 13% of the responses reported in Singida were information on value addition, none on value addition was reported in Iramba. Iramba needs to do more on value addition.

Generally, there was no significant variation in sorghum and finger millet technological information accessed by women and men during the field day (Table 4). It must however be noted that women accessed more information on weed control than men and men accessed more information on grain marketing than women. Nevertheless, for both men and women farmers, a lot remains to be done to demonstrate the benefits of improved fertilizer and manure use, postharvest handling, weed control, disease control, value addition and grain marketing.

Dissemination of information on package recommendations

Package recommendation refers to learning about at least one suitable improved variety of sorghum or finger millet and also at least one critical agronomic practice that enhances the productivity of that variety. Significantly higher proportion of farmers in Iramba as compared to Singida received field technological information as a package while there was no significant variation between male and female participants (Table 5).

In the Iramba district council, the most important technological package recommendation learned by farmers was suitable variety and row planting (Table 6), while in Singida as many farmers learned about suitable variety and row planting as a package recommendation as those who learned only about suitable variety. For both males and females there was no significant difference between the number of farmers who learned about single recommendations (variety only) and the number that had learned about package recommendations (variety and row planting). It is interesting to note that while female farmers learned more about suitable varieties and weed control as a package, their counterparts (men) learned more about fertilizer

Table 3. Percentage of responses by field day participants who reported as having accessed information on various sorghum and finger millet technologies in Iramba and Singida districts of Tanzania

	Percentage responses (N = 106)		
Improved technologies	Iramba	Singida	All
Suitable varieties	33	36	35
Row planting	28	18	22
Seed selection	15	13	14
Fertilizer or manure application	10	0	4
Postharvest handling	5	10	9
Weed control	3	5	4
Disease control	3	3	3
Value addition	0	13	9
Grain marketing	3	2	2

Source: 2015 survey of field day attendees in Nkungi and Ngamu villages

Table 4. Percentage of responses by gender of farmers who have accessed information on various sorghum and finger millet technologies in Iramba and Singida districts of Tanzania

	Percentage responses (N=106)		
Improved technologies	Male	Female	All
Suitable varieties	37	33	35
Row planting	20	24	22
Seed selection	15	13	14
Fertilizer or manure application	3	4	4
Postharvest handling	7	11	9
Weed control	2	7	4
Disease control	3	2	3
Value addition	10	7	9
Grain marketing	3	0	2

Source: survey

Table 5. Percentage of field day participants who reported as having received information as a package in Iramba and Singida districts of Tanzania

District/Gender	Percentage of field day participants reporting information learned a package (N=32)	Chi-square test p-value
Iramba	92	
Singida	58	0.03
All	70	
Male	68	
Female	73	ns
All	70	

Source: 2015 survey of field day participants; ns = not significant

Table 6. Percentage of farmers reporting various combinations of package information learned in Iramba and Singida, districts of Tanzania

	Percentage of farmers and type of package information learned					
District/ gender	Variety & row planting	Variety & weed control	Variety & disease management	Variety & fertilizer use	Variety only	Chi-square p-level
Iramba	63	0	0	13	25	ns
Singida	42	8	4	4	42	
Male	44	0	6	11	39	
Female	50	14	0	0	36	ns
All	47	6	3	6	36	

Source: 2015 field day participants' survey; ns = not significant use on varieties. Furthermore, as learning is a necessary step to technological trial and adoption, it is fair to predict that there was one technological package recommendation (suitable variety and row planting) and one single technology (suitable variety) with a high chance for trial and adoption by farmers in Iramba and Singida. So in the foreseeable future, adoption of suitable variety and row planting as a package and variety as a single technology are expected to propel productivity enhancement for sorghum and finger millet in Iramba and Singida. Nevertheless, a better learning environment for accessing information on weed management and fertilizer application in sorghum and finger millet should be put in place.

Use and perceived satisfaction with information on technologies learned

Farmers were asked whether they had applied the various technologies that they had learned from the previous field days that they had participated in. About 92% of the farmers responded in the affirmative and there was no significant variation in the response either by district or by gender. One interesting finding was that there was a positive correlation ($p=0.05$) between the number of times one had attended field days in the past and use of the new technologies (especially package recommendations). That is, repeated learning or field day attendance enhanced the level of trial or use of a technology. Furthermore, when asked whether they were satisfied with the additional benefits from the new technologies, a good majority of farmers in both the districts reported in the affirmative although the number was significantly higher in Singida than in Iramba (Table 7).

The additional yield benefits from new technologies

The additional yield advantage was highest for package recommendation of variety, row planting and fertilizer application (Table 8). However as fertilizer use was minimal (only 6%), it is predicted that productivity of sorghum will increase mainly by way of adoption of suitable varieties and row planting (12 bags/ha) and by adoption of variety only (8 bags/ha). For finger millet, the best bet technologies for enhancement of productivity will be only by way of adopting suitable variety at 6 bags/ha or variety and row planting at 8 bags/ha. There were no adequate observations for other package recommendations and therefore the yield advantage in these cases is excluded from Table 8. It is recommended that in future a marginal rate of return (MRR) analysis be undertaken to compare returns to various technologies and combinations.

Sorghum production challenges

Key challenges (in descending order of importance) for sorghum production in Iramba were bird damage, pests and diseases, drought, lack of money for fertilizer purchase, and lack of markets. In Singida the key

Table 7. Proportion of farmers (in %) indicating their satisfaction with the use of new technologies in Iramba and Singida districts of Tanzania.

District/Gender	Percentage of field day participants reporting satisfaction with use of new technologies	Chi-square test p-value
Iramba	80	
Singida	100	0.05
All	92	
Male	95	
Female	89	ns
All	92	

Source: 2015 field day participants' survey; ns = not significant challenges were bird damage, pests and diseases, lack of weeding labor, drought and lack of money for fertilizer (Table 9). For men field day goers, the key perceived sorghum production challenges, in descending order of importance, were bird damage, pests and diseases, drought, lack of money for fertilizer, lack of a market for sorghum and lack of weeding labor. For women the key sorghum production challenges were bird damage, pests and diseases, lack of weeding labor, lack of money for fertilizer, and drought. Lack of labor for weeding was of higher importance in Singida than in Iramba and more of a problem for women than for men. Although fertilizer is a productivity enhancer, unless its use is linked to specific interventions to improve its affordability, making use of it will continue to be a challenge for a majority of the farmers.

Finger millet production challenges

The main finger millet production constraints in Iramba were drought, lack of quality seed and a market for finger millet. In Singida they were drought, lack of weeding labor, pests and diseases and lack of money to buy fertilizer (Table 10). According to men farmers, the main finger millet production constraints were drought, lack of a market for the produce and lack of quality seed. Women on the other hand reported the major constraints as drought, lack of quality seed, lack of weeding labor and lack of money to buy fertilizer. By

Table 8. Farmer perceived sorghum yield advantage per ha resulting from use of some recommended practices

	Perceived yield advantage over traditional practice (in 90 kg bags per ha)	
Type of sorghum technological package tried	sorghum	finger millet
Suitable variety and row planting	12	8
Suitable variety, row planting and fertilizer	19	14
Suitable variety only	8	6
Mean	13	9

Source: 2015 field day participants' survey.

Table 9. Current sorghum production challenges faced by field day participants in Iramba and Singida districts of Tanzania

	Percent of responses by the field day participants			
Type of sorghum challenge	Iramba	Singida	Male	Female
Bird damage	29	43	39	33
Pests and diseases	27	20	19	30
Drought	15	10	16	8
Lack of money for fertilizer	8	8	7	10
Lack of a market	8	0	7	0
Lack of quality seed	6	0	4	3
Lack of weeding labor	6	14	7	15
Striga	0	4	2	3
All	100	100	100	100

Source: 2015 field day participants' survey; Percentages not additive due to rounding up.

Table 10. Current finger millet production challenges faced by field day participants in Iramba and Singida districts of Tanzania

Type of finger millet challenge	Percent of responses by the field day participants			
	Iramba	Singida	Male	Female
Drought	35	20	27	35
Lack of quality seed	17	7	14	18
Lack of a market	15	0	16	4
Lack of money to buy fertilizer	7	13	8	10
Late planting	7	13	11	4
Bird damage	7	7	8	4
Lack of weeding labor	6	20	7	13
Pests and diseases	4	20	8	8
Striga	2	0	0	4
All	100	100	100	100

Source: 2015 field participants' survey; Percentages are not additive due to rounding up.

triangulation, the major finger millet production challenges cited more than 10% of the times and by at least two of the responding groups were drought, lack of quality seed, lack of market, lack of money to buy fertilizer and late planting. Nevertheless, pests and diseases were a more prominent problem in Singida than in Iramba. Late planting may be related to the difficulty in finding labor for row planting and the lack of suitable equipment to seed finger millet.

Farmers' recommendations on how to improve effectiveness of future field days

Farmers' key recommendations for improving the effectiveness of future field days (Table 11) were:

- Make field days more frequent and with more training interventions
- Improve access to technological inputs as well as their availability, quality and affordability in time and space
- Improve market linkage
- Motivate more farmers to attend
- Inform farmers well in advance about the date of the field day

The recommendations for improving future field days did not vary significantly with gender of the field day participant. The need for market linkage was felt more in Iramba than in Singida - a reflection that Singida being a regional headquarters and an important market is nearer to farmers in Singida than to those in Iramba. It is important to note that capacity strengthening through training is necessary but not sufficient for adoption of technologies to take place. Enhanced adoption must be accompanied by improved access to input and output markets. The results of this rapid assessment build a strong case for the need to compliment field days with the promotion of seed through SSPs sold through agro-vets. The results also strongly indicate the need for seed subsidies and linkage to sources of credit for seed and other productivity enhancing inputs like fertilizer.

Table 11. Percentage responses on how to improve effectiveness of future field days in Iramba and Singida districts of Tanzania

Type of finger millet challenge	Percent of responses by the field day participants			
	Iramba	Singida	Male	Female
Increase frequency of field days and training	41	53	45	47
Include market linkage	13	0	8	6
Motivate more farmers to participate	13	16	14	15
Subsidize technological inputs	11	8	8	12
Avail inputs early	9	3	8	3
Increase seed access	7	6	6	6
Ensure frequent farmer visits	6	0	4	3
Provide transport	0	5	4	0
Inform farmers early	2	11	4	9
All	100	100	100	100

Source: 2015 agro-vet survey

Small seed (SSPs) and fertilizer packs (SFPs)

Knowledge of the use and the benefits of improved technologies from R4D is necessary but a not and sufficient condition for adoption. Enhancing farmers' access[1] to high quality technological inputs is critical in the adoption process as it enables the farmers to try and evaluate the benefits of the new technology before making a decision to adopt it. If the technology is an improved variety, farmers are willing to try and evaluate a variety they may have seen or heard about, only in a small area of land using a small amount of seed. Therefore, small seed packs (SSPs) become handy in promoting the use of improved varieties among resource-constrained smallholder farmers. The Dryland Cereals Program, in partnership with local partners in the project mandate districts of Tanzania as well as Department of Research and Development (DRD) District Councils (DCs), farmers and agro-vets, have used SSPs to promote the trial of improved sorghum and finger millet varieties (See Annex 1). Actual amounts of improved seed supplied and retailed by two agro-vets each in Iramba and Singida, respectively, are given in Table 16. To complement the SSPs, agro-vets stocking the SSPs were also facilitated to stock small fertilizer packs (SFPs), to help farmers optimize the productivity enhancement advantage of the interaction between improved soil fertility and varieties. Of the four districts in Tanzania with SSP and SFP activity, Singida and Iramba were selected for a survey of farmers who purchased SSPs and SFPs from the participating agro-vets during the 2014-2015 cropping season.

Characteristics of SSP buyers

Out of a total of 515 farmers who purchased SSPs and responded to the questionnaires provided at the four agro-vets, 25% were women and 75% were men. In both districts significantly fewer women than men bought the SSPs, although more women than men reported that they had attended the field days (Table 12). There could be a constraint that prevents women more than men from purchasing the SSPs. The men purchasing the SSPs on an average were six years older than the women.

1. Access means improving availability, information on technological attributes, affordability and diversity of high quality technological inputs in time and space for resource-constrained farmers

Characteristics of SFP buyers

Out of a total of 353 farmers who purchased SFPs, only 19% were women. This points to yet another serious constraint faced by women compared to men in purchasing fertilizers, even though more women than men reported attending the field days (Table 13). The most likely constraint for women would be lack of capital to purchase technological inputs.

In terms of age, there was no significant difference between women and men who participated in the purchase of SFPs. However, the men and women purchasing SFPs were generally five years younger than those purchasing SSPs. Younger farmers find the use of fertilizer more attractive and are more likely to try fertilizer recommendations than older farmers.

Table 12. Some characteristics of SSP buyers in Iramba and Singida districts of central Tanzania

District	Gender	Mean Age	Number (N)	Percent
Iramba	male	43	104	70
	female	37	45	30
	Total	41	149	100
Singida	male	42	278	76
	female	36	88	24
	Total	40	366	100
Total	male	42	382	75
	female	36	133	25
	Total	41	515	100

Source: 2015 agro-vet survey

Table 13. Some characteristics of SFP buyers in Iramba and Singida districts of central Tanzania

District	Gender	Mean Age	Number (N)	Percent
Iramba	male	38	183	84
	female	37	36	16
	Total	37	219	100
Singida	male	35	104	78
	female	36	30	22
	Total	35	134	100
Total	male	37	287	81
	female	36	66	19
	Total	37	353	100

Source: 2015 agro-vet survey

Effectiveness of the agro-vets in easing access of SSPs and SFPs to farmers

In this study there were two ways to gauge the ease of accessing SSPs of seed of improved sorghum and finger millet varieties:

- The distance farmers travelled in order to buy the SSPs from agro-vets
- The distance farmers travelled to obtain information on available improved varieties, their use, end use attributes and potential benefits

Distance to agro-vets

There were two agro-vets each in Iramba and Singida, respectively, which participated in marketing SSPs and SFPs. The number of villages that each selected agro-vet served did not vary significantly by district or by technological input. On an average each agro-vet provided seed and fertilizer retail services to 16 villages (Table 14). The ideal situation would be to have at least one input store in each village with an average of 1,200 households per village. While the distance travelled by farmers to agro-vets did not vary significantly by gender, farmers travelled significantly (p = 0.000) longer distances to purchase SSPs (approximately 16 km) than to purchase SFPs (approximately nine km). Farmers were willing to travel longer distances in search of seed than in search of fertilizer. Fertilizers are complimentary inputs to improved varieties and, therefore, to make fertilizers more accessible to smallholder farmers, the retail outlets (agro-vets) need to operate close (within five km) to potential users. Farmers in Singida travelled significantly longer distances to buy SSPs and SFPs than farmers in Iramba. Singida agro-vets that stocked SSPs and SFPs were far from the farmers. Sensitization and scaling up is necessary so that more agro-vets can be involved in marketing SSPs and SFPs which will improve the accessibility of physical inputs.

Travelling distance to sources of technological information and inputs

Travelling distance to sources of technological information and inputs could be constraints in the acquisition of knowledge, as well as for the trial and adoption of improved technologies. The longer the distance travelled by farmers seeking technological information or physical inputs, the greater the cost of that input. Comparing distance travelled to source information on improved varieties and agronomic practices on the one hand with the distance travelled to buy SSPs, shows that only 37% of the field day participants travelled more than

Table 14. The distance (km) farmers travel to agro-vets for SSPs and SFPs and the number of villages served per agro-vet in Iramba and Singida dsitricts of Tanzania.

District	Gender	Mean distance (km) to agro-vets		Mean number of villages served per agro-vet	
		SSP	SFP	SSP	SFP
Iramba	male	9.7	6.5		
	female	10.2	6.6	16	18
	Total	9.8	6.5		
Singida	male	18.1	14.8		
	female	17.5	10.8	16	14
	Total	17.9	13.9		
Total	male	15.7	9.4		-
	female	15.0	8.5		-
	Total	15.5	9.2	16	16

Source: 2015 SSP & SFP agro-vet survey

five km to seek information from field day sites while a whopping 73% of the farmers who purchased SSPs travelled more than five km (Table 15). Therefore although information on variety and management practice is relatively accessible on field days, trial and adoption is constrained by the inaccessibility of improved seeds; and generally there was no variation between female and male farmers. This means that the access farmers had to information on variety and management practices was far better than the access they had to seeds of improved varieties of sorghum and finger millet. Furthermore, while 73% of the SSP buyers travelled > than five km to access the SSPs, 47% of SFP buyers travelled > than five km to access the fertilizer mini-packs. The inference from the feedback from farmers is that: farmers are likely to travel longer distances for seed (SSPs) than for fertilizer (SFPs). While farmers may buy seed that they were made aware of in a field day, long before the actual planting and further away from home, they buy fertilizer and when they are ready to use it and require the source to be close to their homes. Scaling up SSP activities to include more agro-vets would improve farmers' rate of trial and adoption of new varieties and would also reduce the travel distance and cost of the physical inputs. On the basis of the findings, it is clear that SFPs should be closer (within five km) than SSPs to the target households.

The other conclusion is that: although sorghum and millet R4D activities in Singida and Iramba have made information on improved technologies more accessible to small farmers, accessibility to technological inputs is still constrained by distance to retail outlets and unaffordability. Therefore for the future, the SSP should be scaled up to link more QDS seed producers with a larger number of agro-vets in order reduce the cost incurred by farmers when they travel to agro-vets. Travelling long distances to buy fertilizer increases the transaction costs and price of an already unaffordable fertilizer and this reduces the probability of its use. While the use of SSPs is scaled up to include more agro-vets, arrangements should also be made to hold field days within a distance of five km from target farmers to create more awareness and enhance the demand for physical inputs from the agro-vets.

Table 15. Percentage of farmers who reported having travelled greater than 5 km to seek information, SSPs and SFPs in Iramba and Singida districts of Tanzania.

	Percentage of farmers travelling > 5 km to seek inputs		
District/Gender	Management info	Small Seed Packs (SSP)	Small Fertilizer packs (SFP)
Iramba:			
Male	63	56	34
Female	13	61	36
Total	46	57	34
Singida:			
Male	31	78	64
Female	25	84	62
Total	28	79	64
Gender:			
Male	48	71	45
Female	20	76	47
Total	37	73	47

Source: 2015 agro-vet survey

Demand and preferences for new varieties

Demand and preferences for the SSPs of improved varieties of sorghum and finger millet was gauged in two ways:

- Quantity of available SSPs of seed of improved crop varieties sold by the agro-vets
- The proportion (%) of farmers that purchased the various available SSPs of seed of improved varieties

Quantity of seed of various varieties sold by the agro-vets

Preference and demand for the SSPs of improved varieties was variable across the two districts of Singida and Iramba (Table 16). In Singida there was a high demand for improved varieties of both sorghum and finger millet as about three fourths of the available seed was sold. In Iramba, however, there was a very low demand for NACO sorghum (only 16% was sold) while for Macia there was a high demand as about three fourths of the seed supplied was sold. For finger millet, while all (100%) of the SSPs of P224 supplied to agro-vets were sold, only one fourth of the SSPs of U15 were sold. This preference testing study clearly shows that as of now QDS producers in Iramba should focus on production and marketing of SSPs of Macia and P224 because the study shows sufficient demand for these sorghum and finger millet varieties, respectively. Nevertheless, a focus discussion group (FDG) should be undertaken to investigate the reasons for the low demand for NACO sorghum and U15 finger millet in Iramba district, before any other demonstrations on them are undertaken. In Singida QDS seed production and marketing should focus on all the varieties of sorghum and finger millet.

Table 16. Quantities of QDS seed of sorghum and finger millet supplied and sold in two agro-vets each in Iramba and Singida districts of Tanzania during the 2014-2015 cropping season.

Districts (no of agro-vets)	Crop variety	Amount (kg) of seed of sorghum (SSP = 1kg) and finger millet (SSP = 1/2 kg)		Percent (%) sold
		Distributed	Sold	
Singida	**Sorghum:**			
	NACO	1000	713	72
	Macia	1000	675	68
	Sub-total sorghum	2000	1388	70
	Finger millet:			
	P224	250	215.5	87
	U15	250	191.5	77
	Sub-total finger millet:	500	407	82
Iramba	**Sorghum:**			
	NACO	1000	159	16
	Macia	1000	734	74
	S/total sorghum	2000	893	45
	Finger millet:			
	P224	250	250	100
	U15	250	63	25
	S/total millet	500	313	63

Source: HOPE Technical Report for Tanzania on Small Seed Packs (SSPs) and Small Fertilizer Packs (SFPs) for January-June, 2015

Proportion of farmers purchasing SSPs of available improved varieties

Proportionately, the demand for SSPs of sorghum was higher than those of finger millet. Although Macia was released in 1999, the SSP purchases showed that NACO (released in 2013) was nearly as popular as Macia (Table 17), especially in Singida. Further, in Singida significantly more female (41%) than male (33%) farmers preferred NACO. One concludes that: a) the field days were very effective in disseminating information on agronomic and end use attributes of NACO, and the farmers, especially women, appreciate the agronomic and end use attributes of NACO, and b) the participation of women farmers during field days and PVS was satisfactory or the field days were quite effective in reaching women farmers. No variety of finger millet had been released prior to 2013 when P224 and U15 were released. In Iramba, P224 (14%) finger millet was significantly more popular than U15 (7%), while in Singida there was no significant difference in preference between P224 (12%) and U15 (11%).

Variety diffusion mechanisms

A relevant question would be what proportion of farmers bought SSPs in order to try or experiment with new varieties for the first time? Since experimenting with a new variety is preceded by learning or awareness creation, this group of farmers should have undergone the learning process from an information source. Overall 74% of the farmers who bought the SSPs of improved varieties had never planted the varieties before, while 26% of them had planted the varieties previously (Table 18). In Iramba, 80% of the female farmers who bought seed of new varieties had never used them before. So how did the first time users learn about the new varieties? Farmers were asked whether they had seen or heard about the varieties before deciding to purchase them. Of the 522 farmers purchasing SSPs, 9% had not seen or heard, 22% had heard and 69% had seen the varieties before making the decision to purchase them (Figure 3). Therefore a strong correlation exists between seeing or awareness creation, and purchase of seed of new varieties. As was discussed earlier variety adoption is a three step process: seeing, trial and evaluation, following which a decision to adopt or not adopt is made.

Table 17. Percentage of farmers purchasing SSPs of improved sorghum and finger millet varieties from agro-vets in Iramba and Singida districts of central Tanzania during the 2014-15 cropping season

	Percentage of farmers reporting variety purchased from agro-vets (N = 519)			
District /Gender	Macia	NACO	U15	P224
Iramba:				
Female	33	33	9	26
Male	56	30	6	8
Total	49	31	7	14
Singida:				
Female	47	41	8	5
Male	41	33	12	14
Total	42	35	11	12
Total Gender:				
Female	42	38	8	12
Male	45	32	10	12
Total	44	34	10	12

Source: 2015 agro-vet survey

Table 18. Percentage of farmers reporting first time use of seed of improved sorghum and finger millet through purchase of SSPs from the agro-vets

District/Gender	Percentage of first time users of the variety (N = 535)	Chi-square p value
Iramba:		
Female	80	
Male	56	0.04
Total	63	
Singida:		
Female	70	0.02
Male	83	
Total	80	
Total Gender:		
Female	74	ns
Male	74	
Total	74	

Source: 2015 agro-vet survey; ns = not significant

Where had they seen or heard of the new varieties whose seed they purchased from the agro-vets? Across the two districts the 91% that said that they had seen or heard about the new varieties, had received the information from field days/or farmer field schools/research plots (45%), neighbors' farms (33%), extension (14%), agro-vet (4%) and FIPs (3%) before making the decision to buy and experiment. Therefore the field days were quite an effective way of disseminating varietal information (Figure 4) or creating awareness about their availability and potential benefits.

Correlation between information access and demand for R4D technologies

The HOPE and SMU dissemination activities were highest during the period 2010 to 2014. The improved sorghum and finger millet (Figure 1) and fertilizer (Figure 2) demand curves indicate a strong positive correlation between the intensity of technology dissemination activities and demand (reflected by purchase from the agro-vets) for the farmer preferred varieties. Implementation of activities that enhance learning or lead to awareness creation about the use and benefits of new technologies promote trial and enhance the demand for preferred improved technologies. A closer look at the demand curves of SSPs and SFPs (Figures 1 and 2) shows a similar trend for both the demand curve for improved sorghum and millet varieties as well as the fertilizer demand curve over the same period. One concludes there was some level of awareness creation for package recommendations (variety and fertilizer) that sparked the demand for both variety and fertilizer from the agro-dealers. But a question to ask is was the fertilizer bought used for sorghum and finger millet or for other crops? If it was used for other crops then the field days, demos as well as farmer and input supply platforms simply sensitized farmers on the benefits of fertilizer use and the availability of affordable SFPs. There are further discussions on this in due course.

Correlation between learning method and number of SSPs

Farmers who reportedly saw the new varieties before purchase, bought significantly more SSPs than those who had not seen or heard about them (Table 19). Physically seeing the technologies, their use and potential benefits improves the farmers' confidence on the technologies and increases the likelihood of trial and

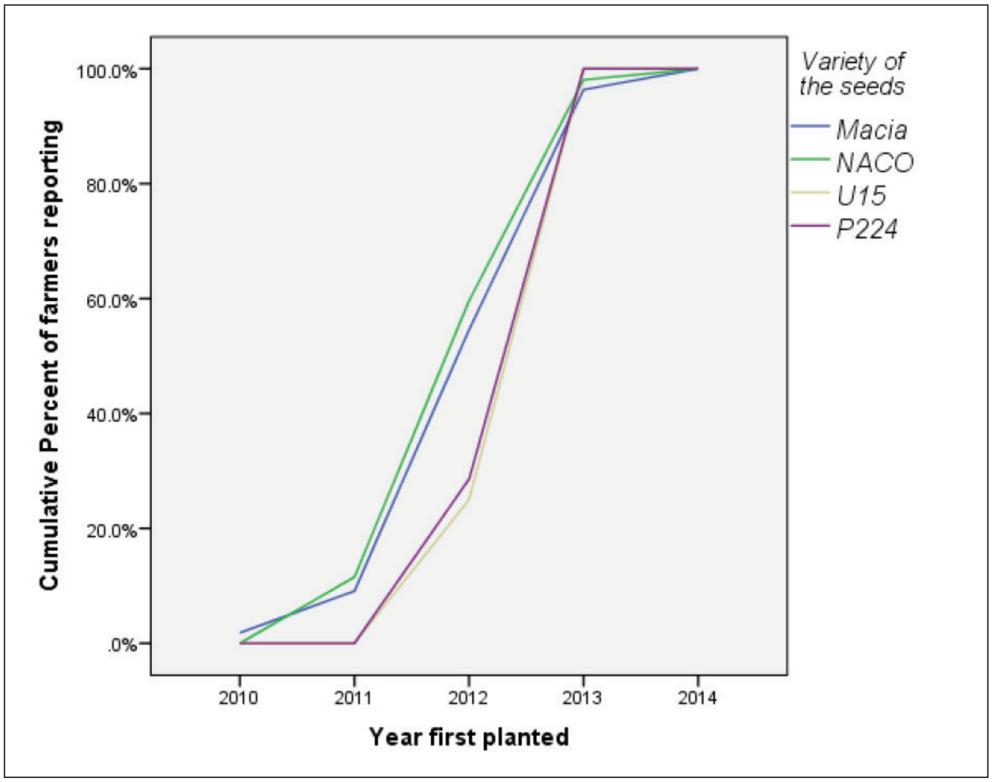

Figure 1. Demand for improved sorghum and finger millet varieties.

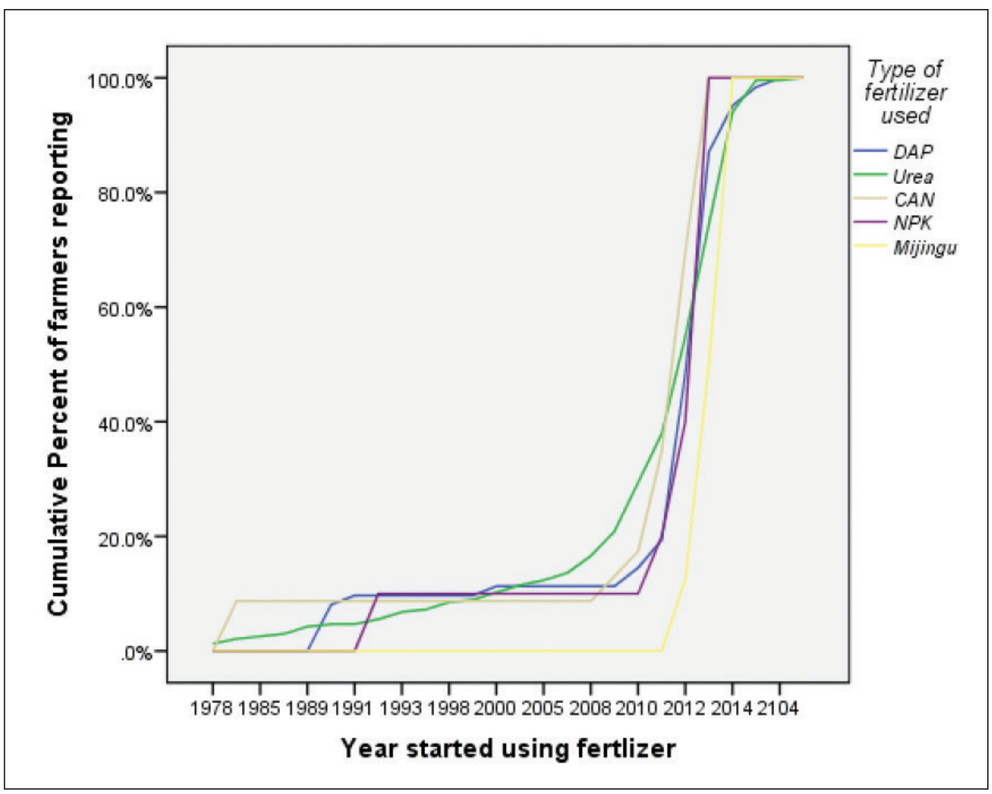

Figure 2. Demand for fertilizer for crop production.

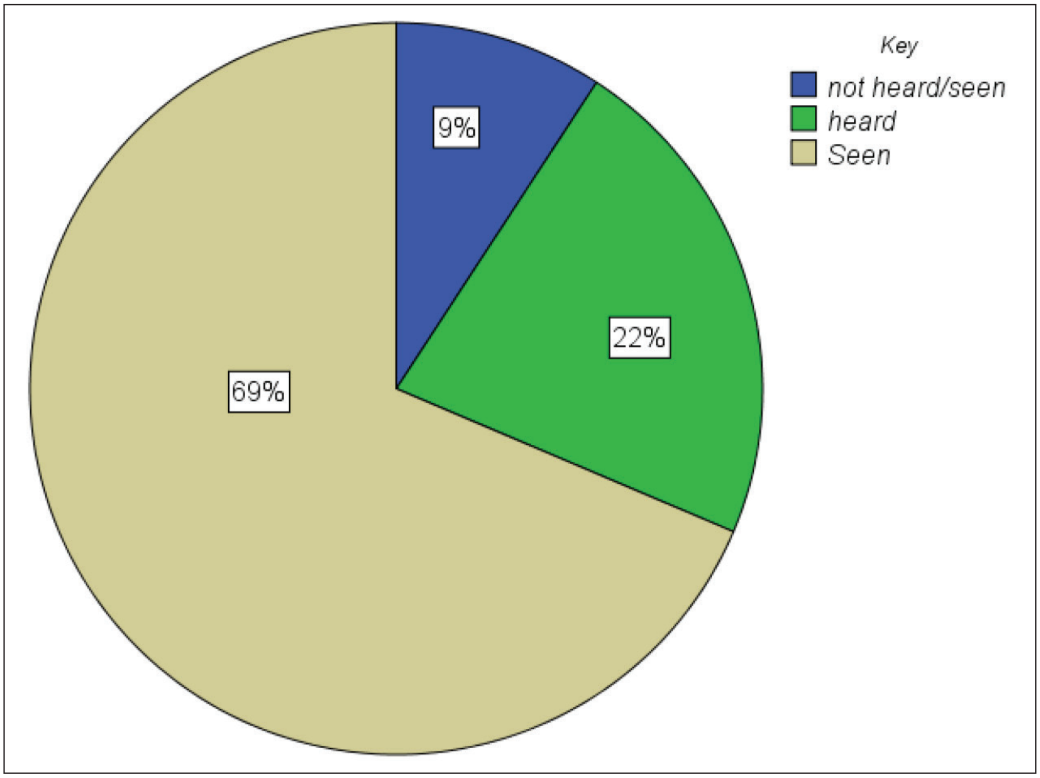

Figure 3. Relationship between learning about use and benefits of new varieties and the demand for them.

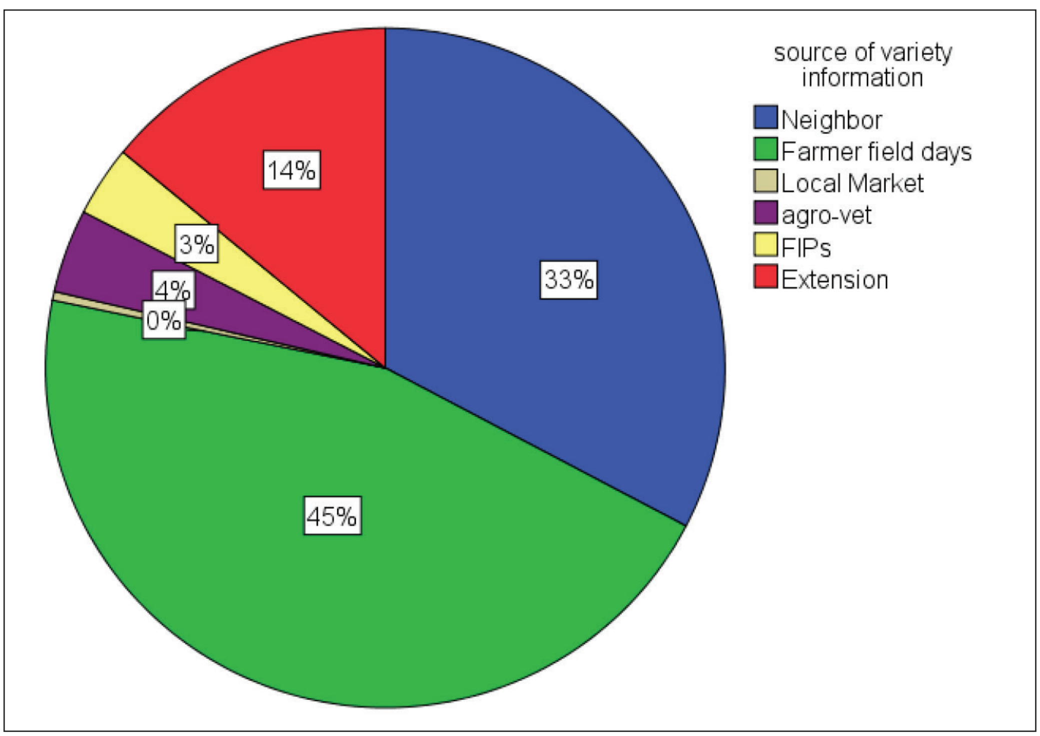

Figure 4. Major information sources from which farmers learn about use and benefits of new varieties.

adoption and therefore the demand for seed. Promoting the demand for seed of improved varieties through field days and demos is critical for improving adoption. Earlier findings from western Kenya showed that it is futile to stock the improved varieties at input retail outlets, without awareness creation through PVS, field days and demonstrations.

Type of fertilizer and gender

The most preferred fertilizer was urea (70%) followed by DAP (19%), although a greater proportion of men (73%) preferred urea (Table 20) than women (55%) and a greater proportion of women (29%) showed preference for DAP than men (17%). DAP is usually used at planting while urea is top-dressed at the first weeding or split and applied at the first and second weeding.

The most preferred SFP size (Table 21) was 1 kg size of urea for both men (51%) and women (35%) followed by 5 kg size of DAP for women (24%) and 5 kg size of urea for men (23%). Women also had a high preference for urea of 5 kg (20%).

Source of information on fertilizer use

The most important sources of information on fertilizer use were other farmers (65%) and field days/farmer field schools (20%) while the minor sources were radio (6%), FIPs (4%), extension (3%) and TV (1%). This underlines the importance of training trainers who can then train others. While field days are popular for delivering messages on improved technologies, especially of improved varieties, radio as an information channel has a huge potential to influence farmer decision making, especially with the mushrooming of local radio stations. However radio, as the results indicate, is more likely to disseminate information to men than to women.

Table 19. The relation between seeing a technology and demand for the technology in Iramba and Singida districts of Tanzania

Have you seen or heard about the type of seeds before coming to buy and ? (N)	Mean SSPs Bought
Not heard or seen (49)	1.98
Heard (118)	2.30
Seen (365)	3.69
Total (532)	3.22
P-value	0.000

Surce: 2015 survey of agro-vets

Table 20. Fertilizer type and gender preference in Iramba and Singida districts of central Tanzania.

	% reporting purchase of fertilizer type				
Gender (N)	DAP	Urea	CAN	NPK	Mjingu
Male (293)	17	73	7	2	2
Female (66)	29	55	4	7	5
All (359)	19	70	6	2	2

Source: 2015 agro-vet survey

Sources of information on variety and fertilizer by gender

The most important source on variety information was field days/farmer field schools (Table 22) for both men (44%) and women (49%), while the most important source on fertilizer information was other farmers for both men (69%) and women (52%). Field days were a major source of variety information because of the active participation of farmers in PVS, which empowered them to select varieties for release, promotion and sale at the agro-vets. The fact that other farmers were a more important source of information on fertilizer than field days has two implications: 1) make more efforts to improve the fertilizer demonstrations during field days, and 2) enhance the use of TOTs for disseminating information on fertilizer use and benefits.

Type of fertilizers used on various crops

What crops were the purchased fertilizers used on? The preferred crops for fertilizer application, according to the buyers who responded to the SFP questionnaire (Table 23), were vegetables (41%), maize (19%), onions (15%), tomatoes (13%) and sorghum (10%). Generally those who bought SFPs did not apply them on finger

Table 21. SFP sizes and gender Percentage in Iramba and Singida districts of central Tanzania.

	Percentage preferences by Gender		
SFP size (N)	Male	Female	All (N=359)
DAP 1 kg (11)	3	5	3
DAP 5 kg (57)	14	24	16
Urea 1 kg (171)	51	35	48
Urea 5 kg (79)	23	20	22
CAN 1 kg (13)	3	5	4
CAN 5 kg (10)	3	0	3
NPK 1 kg (1)	0	2	0
NPK 5 kg (9)	2	6	3
Mjingu (8)	2	4	2

Source: 2015 agro-vet survey

Table 22. Percentage of male and female SSP and SFP buyers reporting sources of information on variety and fertilizer in Iramba and Singida districts of Tanzania.

	Percentage of buyers reporting source of information							
Input/gender	Other farmers	Field days	Extension	Agro-vet	Radio	FIPs	Local market	TV
Variety:								
Male	35	44	12	5	0	3	1	0
Female	28	49	18	1	0	4	0	0
All	33	46	13	4	0	3	1	0
Fertilizer:								
Male	69	16	4	0	7	5	0	0
Female	52	40	0	0	0	5	0	3
All	66	21	3	0	6	5	0	1

Source: agro-vet survey, 2015

millet, pearl millet and beans. Although the demand for both improved varieties of sorghum and finger millet showed a trend similar to that of fertilizer demand (Figures 1 and 2), fertilizer was used mainly on vegetables (69%) and to a lesser extent on maize (19%) and sorghum (10%). There was no attempt to use fertilizer on finger millet. Farmers should be consulted as to why the use of fertilizer on finger millet is not popular before future attempts to promote fertilizer use on finger millet for enhanced productivity are undertaken especially through use of TOTs.

The most important fertilizers used on the preferred crops were urea (70%), DAP (19%) and CAN (6%).

Fertilizer application rates

Of the farmers who bought SFPs, 10% of them used the SFPs they bought on sorghum (Table 23). Of the farmers who used fertilizer on sorghum, 53% used DAP and 33% used urea. What was their rate of application of DAP and urea on sorghum? Computation indicates that those who bought SFPs for sorghum production used a rate of 36 kg per ha for urea and 64 kg per ha for DAP and there was no significant difference in the rate of application by men and women farmers. Regressing DAP application rates by age showed a significant negative association (p value = 0.01) between DAP application rate and age. This means that younger farmers applied higher rates of DAP than older ones. There was no significant association between age and urea application rates although it was also negative. Generally the rule of the thumb for fertilizer use by smallholder farmers on cereals was either to use DAP at planting or urea at weeding but not both. The application rate compared well with the micro-dosing recommendation rates (DAP and urea at 50 kg and 36 kg per ha, respectively) by DRD and ICRISAT in Tanzania.

Fertilizer use on sorghum and distance walked to buy the fertilizer

Table 24 shows that those who bought fertilizer for application on sorghum travelled significantly longer distances (15 km) than those who bought the fertilizer to apply on other crops (9 km). In scaling up of the delivery of sorghum and finger millet technologies, more agro-vets should stock SSPs and SFPs in order to reduce the distance (< than 5 km) farmers have to travel to purchase them.

Table 23. Type of fertilizers and the crops they are used on by those who bought SFPs in Iramba and Singida districts of Tanzania.

	Percentage reporting use of fertilizer					
Crop (N)	DAP	Urea	CAN	NPK	Mjingu	All fertilizers
Sorghum (36)	53	33	0	3	11	10
Finger millet (1)	100	0	0	0	0	0
Pearl millet (1)	0	100	0	0	0	0
Beans (1)	0	100	0	0	0	0
Vegetables (148)	6	87	4	2	1	41
Maize (69)	36	52	4	6	1	19
Onions (54)	17	52	9	0	2	15
Tomatoes (46)	9	67	20	4	0	13
Sunflower (1)	100	0	0	0	0	2
All crops (359)	19	70	6	3	2	100

N = number of farmers responding to the SFP questionnaire.

Satisfaction with use of improved varieties of sorghum and finger millet

Farmers who reported having used the various improved varieties prior to purchase of SSPs were asked to state their level of satisfaction (a bit, very satisfied or not at all satisfied) with the performance of the improved varieties. The responses (percent) are given in Table 25. The majority of the SSP buyers were very satisfied with the performance of the new crop varieties. Further analysis for sorghum (finger millet omitted in this analysis because of fewer observations) showed no significant difference in reported level of satisfaction between males and females or between districts for SSP buyers.

Level of satisfaction with benefits of fertilizer use

The SFP buyers were asked to indicate the level of satisfaction with performance following fertilizer use on sorghum compared to other crops. Table 26 is a representation of their responses. The majority of the SFP buyers were satisfied at having used fertilizer on sorghum although a higher proportion was very satisfied with fertilizer use on other crops (mainly vegetables) as compared to sorghum. This is perhaps a reflection of the status of vegetables as a more important cash crop than sorghum.

Reason for non-satisfaction with SSPs and SFPs

Those SSP buyers who were not satisfied with performance of improved varieties of sorghum and finger millet were asked to state the reasons for their dissatisfaction. Their responses show that 41% were not satisfied due effects of late planting while others stated pests and diseases (24%), low yield, especially Macia (12%) and poor germination for Macia (9%). Dissatisfaction with the use of SFPs was mainly due to drought (61%) and unaffordability of fertilizer, especially urea (27%) while 6% did not know the reason for their dissatisfaction. While demonstrations on the benefits of early planting will be important, interventions to minimize the effects of drought (including early planting), pests and diseases and unaffordability of fertilizers need to be implemented in order to enhance the productivity of sorghum and finger millet in Iramba and Singida districts of central Tanzania.

Table 24. Distance farmers travelled to agro-vets and use of SFPs on sorghum in Iramba and Singida districts of Tanzania.

Fertilizer use on sorghum (N)	Mean distance (km) travelled to agro-vet	p-value
No (316)	8.7	
Yes (38)	14.5	0.000
All (353)	9.3	

Source: 2015 agro-vet survey.

Table 25. SSP buyers' satisfaction with the performance of improved sorghum and finger millet varieties in Iramba and Singida districts of Tanzania.

	Percent of SSP buyers reporting level of satisfaction	
Crop variety	A bit	Very satisfied
Macia	36	64
NACO	31	69
U15	0	100
P224	29	71
All varieties	32	68

Source: agro-vet survey, 2015.

Table 26. SFP buyers' satisfaction with the benefits of fertilizer use on improved sorghum varieties in Iramba and Singida districts of Tanzania.

	Percent reporting level of satisfaction		
Crop	A bit	Very satisfied	Not all
Sorghum	37	47	16
Other crops	10	88	2
All crops	13	83	4

Source: 2015 agro-vet survey.

Annex 1: SSPs & SFPs Activity

Harnessing opportunities for productivity enhancement (HOPE): Technical Report for Tanzania on Small Seed Packs (SSPs) and Small Fertilizer Packs (SFPs) for January-June, 2015

1.0 Advocate /experiment with provision of small fertilizer packs (SFPs) by agro dealers in Tanzania

Rationale

Continuous cropping by smallholder farmers without any replenishment of soil nutrients has led to soil mining and low productivity of sorghum and millets in ESA, estimated to be about 0.5 t per ha. Fertilizer is a derived input and the demand by farmers depends on the pricing of the fertilizer and the value of grain it produces. Micro-dosing has potential to increase sorghum and finger millet yield by 40%. Therefore, the HOPE project has embarked on promoting and marketing small fertilizer packs (SFPs) and micro-dosing in order to enhance the affordability and adoption of fertilizer as well as its use efficiency. Selected agro-dealers in Kondoa, Singida, Iramba and Rombo in Tanzania were provided with technical support and information for the timely marketing of fertilizer in affordable SFPs to small scale farmers. The implementation procedures and timing of this activity was dictated by the local conditions, stakeholder needs and the commencement of the rainy reason.

Methodology

In Tanzania, two agro-vets (identified by extension), one in each of the four mandate districts were invited to a stakeholder meeting which included farmers, extension-staff and researchers to plan this activity. The stakeholder meeting, held about three months before the beginning of the cropping season which started during December 2014 and January 2015, made recommendations on i) the type of facilitation needed, ii) the types and amount of fertilizer to be stocked, iii) the size of fertilizer packs, iv) the type of training needed, v) monitoring mechanisms, and vi) the timing of fertilizer mini-pack marketing. The training and publicity was done by the extension while the agro-dealers purchased the agreed quantities and types of fertilizer and also administered a short questionnaire to collect feedback from farmers on the preferred information channels and the impact of fertilizer use on sorghum and finger millet. While re-packaging of fertilizer was also done by the agro-dealer, the labor expense for repackaging was paid for by the project. A one page questionnaire, to be administered by the agro-vet, was provided for farmer feedback on: i) the gender and age of the farmer, ii) fertilizer pack-size and type preferences, iii) preferred information channels, iv) crops that the purchased fertilizer would be used on and v) the perception of past benefits of fertilizer use. These questionnaires will be collected in April, 2015 (the end of the fertilizer purchase period), analyzed and reported.

Results

In Tanzania, although fertilizer marketing (especially top-dressing fertilizers) continues to date, the actual amount, types and size of fertilizer packs bought will only be known by the end of March 2015; the amount, types, and pack sizes proposed by stakeholders to be stocked by agro-dealers at the start of the season are given in Table 1.

Furthermore in each district there were two training sessions on sorghum and finger millet agronomy for farmers and agro-dealers. In addition sensitization meetings were held to publicize and promote the sale of fertilizer mini-packs and micro-dosing. Posters for publicity and pricing were also placed in the towns where the agro-vets were located (Figure 1).

Implications

As we wait for the remaining results of this activity including the analysis of feedback information from farmers, the lessons learnt so far from Tanzania are that:

- It is normal for agro-vets to retail small quantities of fertilizers and it is also legal in Tanzania. There is absolutely no need to assist agro-vets in packaging the mini-packs. The farmers come with their own containers and can buy as little or as much fertilizer as they can afford.

Annex Table 1. Stock of fertilizer mini-packs for marketing in agro-vets in Iramba, Singida, Kondoa and Rombo districts of Tanzania.

Fertilizer pack size (kg)	Iramba	Singida	Kondoa	Rombo
1	8500	8000	6000	7000
5 &10	11400	10000	8000	12000

Note: Type of fertilizers include DAP, urea and CAN

Figure 1. Sample of posters on fertilizer promotion used in HOPE project mandate districts in Iramba, Singida, Kondoa and Rombo districts of Tanzania.

- The key areas to concentrate on in the future are publicity through posters, demos and radio as well as training of farmers and agro-vets.
- A credit component for agro-vets and farmers would help enhance the supply and demand, respectively, for agro-vets and farmers, although this point will be more conclusive after analysis of the feedback currently being collected.

2.0 Follow-up survey of Small Seed Packs (SSPs) in Tanzania to determine use and consequences

Seed is the most important basic resource in farm production and without access to high quality and affordable seed, farmers cannot improve crop productivity and household incomes from surplus sales. Resource poor farmers use only small quantities of seed to tryout and evaluate new varieties before adoption. Furthermore most farmers, being resource poor, can afford only small quantities of improved quality seed stock in the adoption phase and use it to start their own seed stock.

Therefore the HOPE project in the first four years used small seed packs that were distributed to farmers free of cost as a strategy to promote seed of improved varieties of sorghum and finger millet. The estimated sorghum mini-seed packs distributed were: in Eritrea (3,200), Ethiopia (2,934) and Tanzania (5,000). The finger millet mini-seed packs distributed were: in Ethiopia (2,827), Uganda (10,200), Tanzania (1,780) and Kenya (11,800). While there is still a need for mini-seed packs, there is limited information on demand, on preference differences across gender and on the various districts. This information is critical for the success of future seed marketing activities, especially for the new varieties.

Therefore this activity was implemented to further popularize the improved varieties of sorghum and finger millet as well as to establish the demand and preferences of these varieties across HOPE mandate districts. This activity was prioritized as being of utmost importance in stakeholder meetings which were organized, in the respective countries, to plan this and other activities during the HOPE bridging phase. The stakeholders suggested that for sustainability, the farmer based seed production should produce and package the SSPs which should then be sold to agro-vets.

Methodology

A stakeholder meeting (consisting of farmers, agro-vets/seed shops, extension and researchers) that was organized to plan the activity agreed that the farmer seed producer groups should avail of and package the SSPs under the supervision of the extension and that the seed will be purchased from agro-vets (Kenya and Tanzania) or seed shops (Uganda). The other issues that the stakeholder meeting discussed were:

- How to facilitate the process through a revolving seed fund
- Roles (seed treatment, seed certification, packaging, transport, etc) to be played by different stakeholders
- Finger millet and sorghum varieties and amounts to be marketed
- Selection of agro-vets and their locations
- Pricing structure: seed producer sale prices and agro-vet retail prices (Table 3)
- Timing of the activity
- Collection of data from farmers to monitor seed demand, variety preferences and gender considerations

In Tanzania, two agro-vets each were selected in Iramba, Singida, Kondoa and Rombo to market mini-seed packs of sorghum and finger millet produced and packaged by two community based seed producers based in Iramba and Singida districts, respectively and certification was done by TOSCI as QDS seed.

Due to the high level of seed recycling of sorghum and finger millet seed, it was agreed that the project will subsidize (Table 2) farmers at 200 and 300 Tshs per kg for sorghum and finger millet seed, respectively. This would motivate farmers to buy seed from the agro-vets as the prices would be affordable, although they would still be twice the price of grain in the local market.

In Tanzania, prior to the beginning of the cropping season, farmers and agro-dealers were trained. In addition publicity was built up through posters in market centers and announcements in prayer houses.

Results and discussions

Training and publicity

In Tanzania training and sensitization of key stakeholders was organized in the four districts in which improved finger millet and sorghum mini-seed packs were marketed. The type and number of stakeholders trained and sensitized in sorghum and finger millet agronomy are given in Table 3.

Quantity of SSPs distributed and marketed

The seed marketing season in Tanzania ended in January 2015 and the preliminary results for mini-seed distributed and marketed are indicated in Table 4. Farmer preferences and the demand for improved varieties

Annex Table 2. Seed pricing structure for sorghum and finger millet agreed by consensus in stakeholder meeting in Tanzania (Yield: sorghum (8 bags/hectare); finger millet (6 bags/hectare))

	In Tshs per kg	
Cost components	Sorghum	Finger millet
Seed production cost	500	700
Seed dressing	50	50
Transport	50	50
Packaging &labor	100	100
Farmer margin	300	400
Seed cost	1000	1300
Agro-vet margin	200	200
Retail price of seed	1200	1500
Project subsidy to farmers	200	300
Subsidized price[2] by project	1000	1200
Revolving fund	800	900

Source: HOPE Technical Report for Tanzania on Small Seed Packs (SSPs) and Small Fertilizer Packs (SFPs) for January-June, 2015

Annex Table 3. Type and number of key stakeholders trained in Iramba, Singida, Kondoa and Rombo districts of Tanzania.

	Number trained in the districts			
Type of stakeholder	Iramba	Singida	Kondoa	Rombo
Farmers	60	75	50	241
Agro-vets	2	3	3	4

Source: HOPE 2015 technical report

of finger millet and sorghum vary with districts. In Iramba, P224 is in high demand as 100% of the SSPs were sold while U15 shows a relatively low demand (25% sales) and perhaps calls for more demo activities for U15 in Iramba after verifying in FDGs why it is not preferred. NACO, an improved sorghum variety released in 2013, was in low demand in Iramba (only 16% sales) but exhibited a high demand in Singida (72% sales). Perhaps before more demos of NACO are undertaken, it is necessary to verify through FDGs the reasons for its low demand in Iramba. Although P224 was in high demand in Iramba, generally, the demand for improved varieties was higher in Singida than in Iramba. The reason for this variation in demand between Iramba and Singida needs to be investigated.

Further, SSPs of NACO (250 kg or 250 SSPs), Macia (250 kg or 250 SSPs), P224 (62.5 kg or 125 SSPs) and U15 (62.5 kg or 125 SSPs) were distributed to two agro-vets each in Rombo and Kondoa districts, respectively. Results showed that the demand for improved varieties from retail agro-vets in Rombo and Kondoa was fairly high. Overall out of the total no of mini-seed packs distributed to agro-vets, 67% were sold.

Furthermore a total of Tshs 1,517,400 (USD 760) and Tshs 1,027,400 (USD 520), the sum total of the agro-vets' margins of 25%, was returned to Singida and Iramba District Councils, respectively. This was to be used in a revolving fund for further facilitation of commercialization of QDS by retailing of SSPs of improved varieties of sorghum and finger millet through agro-vets.

Annex Table 4. Amount of QDS seed of sorghum and finger millet distributed and sold and agro-vet commission (25%) and money returned to a revolving fund for future QDS production and commercialization in Iramba and Singida districts during the 2014-2015 cropping season.

		Amount (kg) of seed of sorghum (SSP=1kg) and finger millet (SSP=1/2 kg)			Income in Tshs	
Districts (no of agro-vets)	Crop variety	Distributed	Sold	Percent (%) sold	Agro-vet commission or retail margin	Seed revolving fund
Singida (5)	Sorghum:					
	- NACO	1000	713	72		
	- Macia	1000	675	68	277600	1110400
	s/total sorghum	2000	1388	70		
	Finger millet:					
	- P224	250	215.5	87		
	- U15	250	191.5	77		
	s/total millet	500	407	82	81400	407000
Iramba (2)	Sorghum:					
	NACO	1000	159	16	178600	714400
	Macia	1000	734	74		
	s/total sorghum	2000	893	45		
	Finger millet:					
	P224	250	250	100	178600	714400
	U15	250	63	25		
	s/total millet	500	313	63	62600	313000

Source: HOPE 2015 Field Technical report

Figure 2. Two of the 11 agro-vets stocking SSPs of sorghum and fertilizers packs in Tanzania.

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