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Full Length Research Paper

Participatory market-led cowpea breeding in Sub-Saharan Africa: Evidence pathway from Malawi and Tanzania

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Abstract

This paper presents a pathway followed by the Alectra research project group in Tanzania and Malawi breeding cowpea for Alectra resistance and for the market. The main objective of the project was to develop cowpea varieties which are resistant to parasitic weed Alectra vogelii and promote the same to small farmers in Malawi and Tanzania. The paper is based on-station and on-farm trial data collected at Ilonga, Bihawana, and Ismani research stations in Tanzania and at Bunda College in Malawi. On-farm data were collected from 2 Extension Planning Areas in central Malawi and 6 villages in Singida, Dodoma and Iringa regions. Lilongwe and Kasungu in Malawi and Dodoma, Iringa and Singida were the main areas where we collected consumers' preference data. The pathway shows that starting from 180 breeder lines, only 13 lines including B301, IT99K-7-21-2-2-1 IT99K-494-6 and IT99K-753-1 and turned out to be very promising lines against A. vogelii infestation. However after subjecting the same lines to various consumer/market preference indicators such as seed color and size, many lines were dropped hence could not be officially released. This study conclude that market based research has resulted in releasing highly demanded varieties that will stimulate production and increase income of small producers in the two countries.

Keywords: Cowpea, consumer preference, market demand, and variety release.

INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Wallp.) is an inexpensive, high quality source of protein of major importance to the nutrition of poor rural households in sub-humid and semi-arid areas of sub-Saharan Africa (Singh *et al*., 2003). Botswana, Kenya, Malawi, Mozambique, Tanzania, Zimbabwe and Zambia are important cowpea producing countries in East and Southern Africa (Singh and Sharma, 1996, Karanja *et al*., 2012). One of the major constraints of cowpea farming in this region is a parasitic weed known as *Alectra vogelii*.

The economic values of cowpea have long been recognized in Africa, particularly as a subsidiary crop to be relied upon during hunger season. In Tanzania and other developing countries in the tropics, cowpea has been regarded as an important leguminous crop catering for food security, nutritional value and for income generation. Liwenga (2003) argued that the reasons for food insecurity were due to the fact that the food base has shifted from the use of traditional crops such as millet sorghum, cowpea and cassava to maize, rice and beans

which need more rainfall. However with the increasing threats of climate change (see Hella *et al*., 2007), high resilience crops such cowpea and cassava (i.e. climate smart crops) can tolerate drought and ensure harvest where other crops cannot match. The periodic food insecurity experienced by 40% of the country's population (see Haug *et al*., 2009; Liwenga, 2003), could be overcome through increased production and improved marketing efficiency of cowpea in both Tanzania and Malawi.

However, currently the cowpea marketing system is not effective inspite of providing an important food source to a large segment of the population in terms of its high protein content, minerals and vitamins. Although there is little improvement in the competitive structure of the marketing system (see Urio, 2005), the market is dominated by a large number of small traders who are not specialized and lack transport facilities. Very little is known about cowpea marketing systems in East and Southern Africa compared to West Africa (Mishili *et al*., 2007; Faith *et al*., 2011). In East Africa cowpea researches (e.g. Singh *et al*., 2003; Singh and Sharma, 1996; Marandu, 2005) had concentrated on agronomic practices, production constraints, diseases and processing/utilization. Very few studies have addressed on cowpea marketing (e.g. FAO, 2002; Urio, 2005) and most of them are lacking information on cowpea marketing efficiency and strategies to improve its marketing system or have been overtaken by the current market demand.

Analysis of market potential for cowpea both in Malawi and Tanzania provided yet another puzzle in that, while farmers complained that there is no market for the little cowpea produced at the markets signs of limited supply that pushes prices were reported in major towns of Lilongwe, Kasungu in Malawi (Chilongo, 2008) and Dar es Salaam, Morogoro and Tanga in Tanzania (Martin, 2008). It is from this reality that this study was conducted as directed by hypothesis that efficient cowpea marketing is hampered existing knowledge between what is demanded by the consumers through the outlet markets and what is produced by the farmers.

METHODOLOGY

Theoretical framework

Demand and supply theories are the leaders in presenting the framework for analyzing this paper. Although cowpea is a crop for household consumption but the recent changes in social, economical, and environmental settings in rural Tanzania and Malawi is slightly influencing the crop to be produced for the market. Production is thus a function of the household (H_{use}) and market requirements (M_{sale}) as expressed in equation 1 below.

$$P_{farm} = f(H_{use} + M_{sale}) \quad \ldots\ldots (1)$$

However, in the short time period the rate of change of the amount of cowpea (grain and leaves) for home consumption is negligible due to the slow rate of change on number of household members from $t_n > t_{n+1.}$ In this context market has a huge role in influencing variation of cowpea production at farm level.

Market demand is a function of several factors such as own price, price of close substitutes, availability, taste, qualities (seed colour, seed size, cooking ability) and the level of processing (defined as $(\partial_1 \ldots\ldots\ldots\ldots \partial_n)$ as outlined in equation (2).

$$P_{farm} = B_1 + \partial_1 \ldots\ldots\ldots\ldots \partial_n \, , \quad \ldots\ldots (2)$$

Hence at short time period $P_{farm} = M_{sale}$ thus justifying our breeding pathway that have focused on developing varieties that are resistant to parasitic weed *Alectra* attack but keeping abreast with the traits which are required by the market.

Location of the study

Data for this study was collected in Malawi and Tanzania. In Malawi we collected both qualitative and quantitative data in Mbewe and Mpokwa Extension Planning Areas (EPAs) in Chikwawa and Zomba districts respectively. The two EPAs are the study sites for the McKnight funded cowpea project. Mpokwa EPA has a total of 29,891 farm families. Of these, about 25% grow cowpeas. The EPAs have a total land area of 29,272 hectares of which 18,932 hectares are arable land. The cowpea land area is estimated at 15% of the arable land. Thus the average total household arable land holding size is about 0.6 hectares. Average household cowpea land size is 0.4 hectares. Given the small total average land size, it was expected that most farmers would be intercropping the cowpeas. Mbewe EPA is composed of 18,369 farm families. Slightly over half (54%) of these households grow cowpeas. However, because cowpea preferences were also sought from traders, other areas beyond the two EPAs were also involved. (Figure 1)

In Tanzania the data were collected from 8 villages, i.e. Msungua, Nduu and Ikhanoda (Singida rural district), Kikombo and Mpunguzi (Dodoma urban district) and Mangalali, Mukungugu and Ilambilole (Iringa rural district). These areas are in semi-arid agro-ecological zone of Tanzania where common beans are not grown thus nearly 90% of the farmers in rural and urban areas grow cowpea both for food and cash income. Like in Malawi, the consumer preference data were obtained in Singida, Dodoma, Morogoro and Dar es Salaam urban centres.

Data collection and analysis

Both primary and secondary data were used. Primary

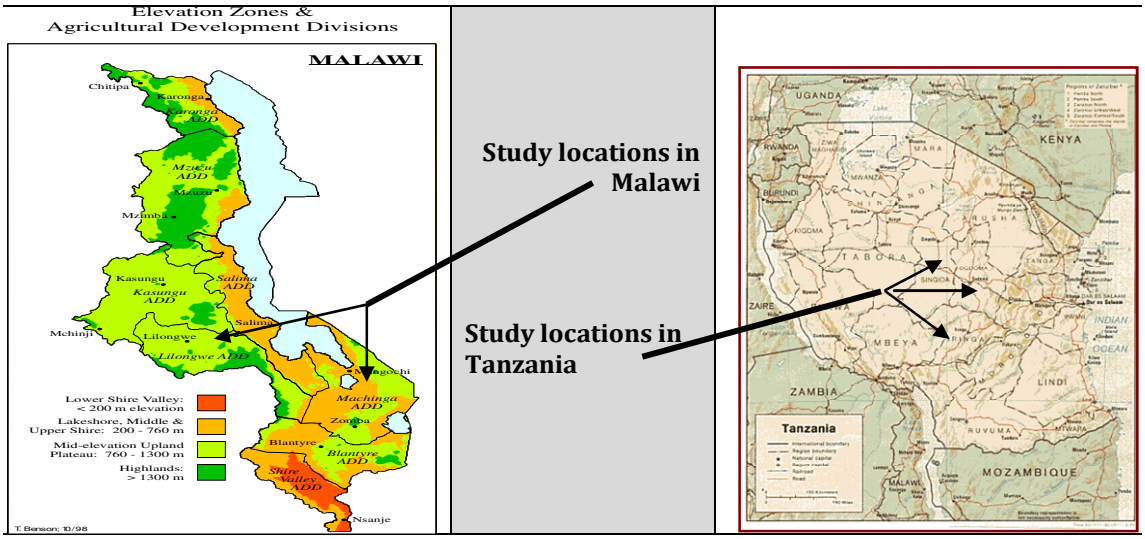

Figure 1. Locations of the study in Malawi and Tanzania.

data were collected by using structured questionnaire, checklists and key informant surveys directed to farmers, traders and extension officers in above mentioned locations. Secondary data were collected from various sources in respective countries including internet sources. Data collected by structured questionnaire were entered in SPSS computer programme for the analysis according to the thought objectives. Qualitatively collected data were analyzed descriptively and were meant for verifying information generated from quantitative sources.

RESULTS AND DISCUSSION

Cowpea breeding pathway

Alectra vogelii was first reported this part of Africa in 1990 (Mbwaga, 1991) it was not until recently when it has started to attract the attention of many scholars (e.g. McKnight Foundation, 2007; Mbwaga *et al*., 2007). In Tanzania, *A. vogelii* is common in almost all cowpea growing regions in central, around Lake Victoria, southern highland and southern Tanzania. In Malawi, it is commonly reported in Lilongwe, Kasungu and lakeshore areas and districts in central Malawi, the lower lying, drier areas of the southern region and the Blantyre/Shire Highlands (Kabambe *et al*., 2008 and Mainjeni, 1999).

Since 2006 McKnight Foundation through the Collaborative Crop Research Programme (CCRP) funded initial effort to conduct research about the parasite in Malawi and Tanzania. The objective of the project was to improve cowpea productivity on *A. vogelii*-infested land in Malawi and Tanzania by introducing *Alectra* resistance into cowpea cultivars that are also early maturing, pest/disease tolerant and high yielding. The specific objectives were to develop high yielding *A. vogelii* resistant cowpea cultivars and then to promote them in both countries, Malawi and Tanzania. Over the period of six years the results have shown some cowpea cultivars/lines that are earlier maturing, high yielding and more tolerant to key and diseases and are resistant to *Alectra* infestation.

In order to be abreast with developing varieties that are resistant to *Alectra* attack, a value chain approach was used to link cowpea production, utilization and market. This was intentionally done to avoid past failures whereby researchers developed varieties (e.g. Sudan 1 in Malawi and Vuli & Fahari in Tanzania) with excellent agronomic traits but didn't carter for farmers' preference and market requirements.

Farmers' cowpea preferences

In developing a research pathway, farmers' preferences on cowpea crop were sought. Here on- farm evaluation of most promising lines of cowpea was conducted between year 2008 and 2010 in eight villages namely; Msungua, Nduu and Ikhanoda (Singida rural), Kikombo and Mpunguzi (Dodoma) and Mangalali, Mkungugu and Ilambilole (Iringa) and Mbewe and Mpokwa Extension Planning Areas (EPAs) in Chikwawa and Zomba districts respectively. In each assessment the farmers first identified criteria for selecting best cowpea lines. Important criteria for selection included early maturity, high yield, resistance to *Alectra* and diseases, brown/white seed color, taste, and drought tolerance, large seed, many leaves and tender (Figure 2). Note that out of 11 indicators for preferences as suggested by farmers five are specific to the final consumers and remainders are field/agronomic characteristics. Large

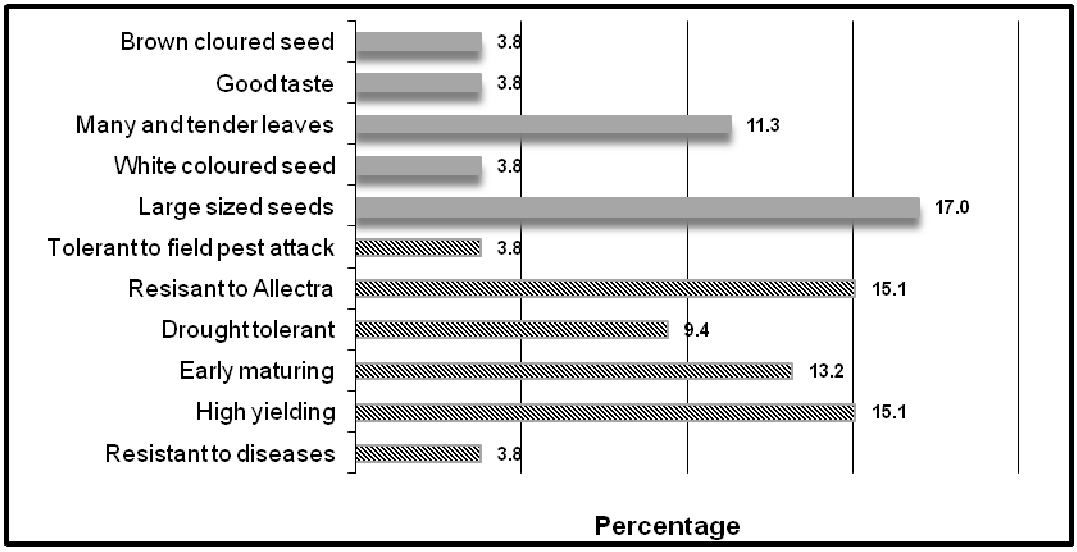

Figure 2. Important traits required by farmers (%).

sized seed was the most important market characterizes while high yielding, resistant to *A. vogelli* attack and early maturing and high yielding were important agronomic criteria used by farmers when selecting variety to grow.

Cowpea marketing and consumer preferences

Studies on cowpea marketing have been conducted in many parts of Africa especially in West Africa (see Lowenberg-De Boer *et al*., 1999; Fery, 2002). In Tanzania and Malawi, the situation is slightly different. Evidence suggests that despite the increasing cowpeas demand for human consumption and income generation, the production trend for the market is declining. For example in Mbarali and Njombe districts in Tanzania, cowpea production decreased from about 400 Kg per ha in 2000 to almost 100 kg per ha in 2004 (Urio, 2005, Gabriel 2008). Similar situation has been reported in Malawi (Kazira, 2009; Chilongo, 2008; Gabriel, 2008). Due to high demand for cowpeas associated with the low production in the country, one would expect high prices of cowpeas to stimulate its production; but this is not the case. Production of cowpeas at small holder level has never been driven by the market demand at neither farmer's level nor consumer's level. Studies by Price *et al*. (1982); Quin (1997); Urio (2005) reveal general low production trends of cowpeas in Tanzania while markets are not well defined despite the increasing role of cowpeas in small holder farmers system. This situation again presents many of unanswered questions which the *Alectra* project planned to address.

Based on data collected in Malawi and Tanzania, cowpea preferences are highly subjective. According to the respondents in Malawi the cowpea seed coat colour is a dominant trait that influences preference among the consumers and hence the traders. In Malawi, dominant colours were brown, red, white and mottled (spotted). According to traders and hence the consumers brown colour was most preferred as is presented in Figure 3a and 3b.

From Figure 3, it is observed that about 80% and 90% of producers and traders respectively preferred brown-coloured skin of cowpeas. The other colours (red, white and mottled) were each preferred by less than 10% of the respondents. The same skin colour preference was observed when comparing the two EPAs. In both EPAs, brown was the most preferred colour (Figure 4). About 72% and 85% of producers in Mpokwa and Mbewe EPAs respectively preferred the brown skin colour to the other colours. The preference of brown skin agreed with focus group discussions that were conducted. In Mpokwa EPA the second most preferred colour was mottled while in Mbewe EPA white was the second best preferred colour.

In Tanzania it was slightly different from Malawi. Seed size was the most important criteria preferred by the consumers as recorded by more than 40% of the respondents. Seed colour was of little importance in Tanzania compared to Malawi since much of the cowpea grain which enter the market are dehulled first to remove the outer coat before making dull for cooking buns, and other composite flour.

Breeding strategies to incorporate consumers/market preferences

For work in Tanzania 130 cowpea accessions were assembled from different institutions. These included 33 accessions from Ilonga Agricultural Research Institute

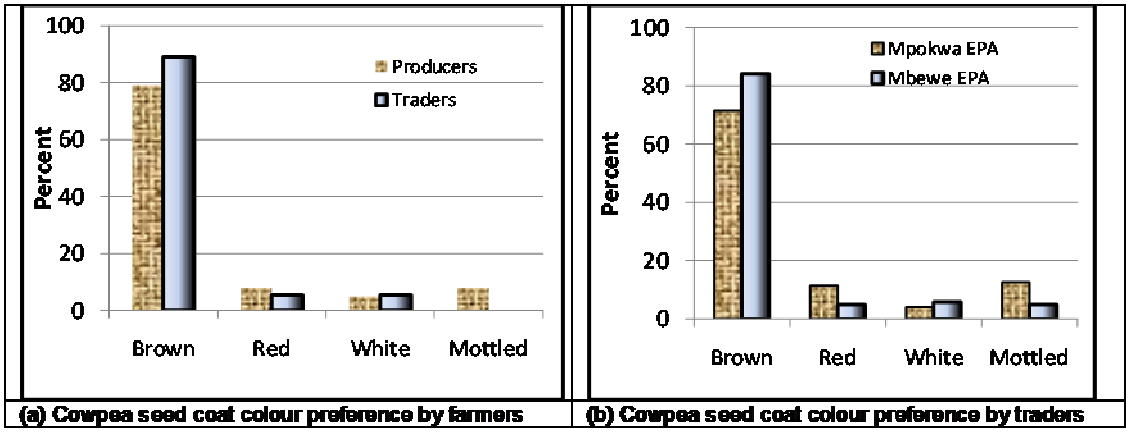

Figure 3. Cowpea Skin Colour Preference by Producers and Traders in Malawi.

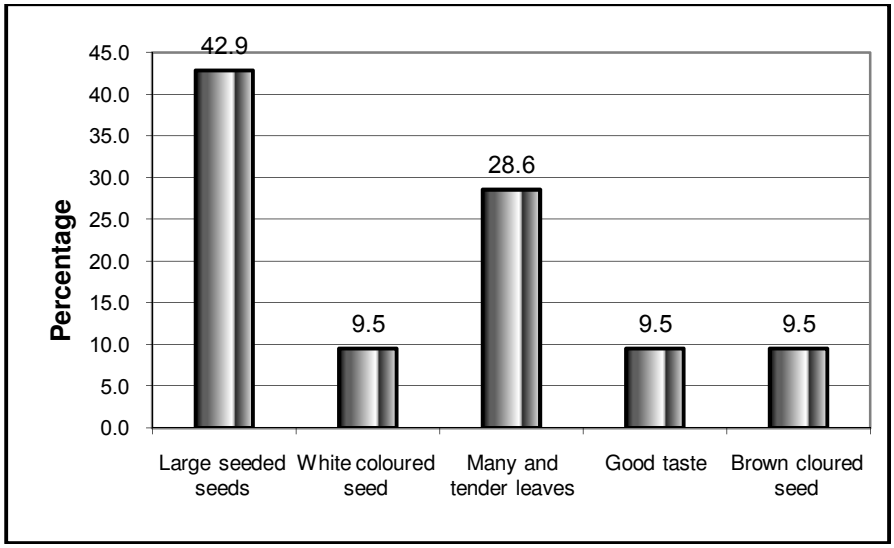

Figure 4. Market preference for cowpea in Tanzania.

(IARI), 30 from the National Plant Genetic Resource Center (NPGRC), 17 from Bihawana Farmers Training Centre (BFTC) and 50 accessions from the International Institute of Tropical Agriculture (IITA). Material from IITA included advanced lines from the breeding programme with genes conferring resistance to the related parasitic weed *S. gesnerioides* and which also provide resistance to *A. vogelii* in West Africa. Furthermore 106 seed accessions were collected from farmers in project areas during the season.

In Malawi germplasm evaluation concentrated on the 50 lines obtained from IITA with two locally grown cultivars included in pot and field trials as checks. A collection of cowpea lines currently grown by farmers (landraces and previously released cultivars) was made during the crop season. Pot trials were used in Malawi, Tanzania and UK to screen germplasm collections for resistance. These involved growing test plants in soil artificially infested with *A. vogelii* seed. Observations were made on the number of parasite stems emerging per host plant. Trials were maintained for 78, 84 or 98 days from sowing in Tanzania, UK and Malawi respectively. One accession of the parasite was used in Malawi, two in Tanzania while the trial in UK compared cowpea reaction to four accessions of *A. vogelii* collected from different areas of Tanzania and one from Malawi (See McKnight reports, 2007). In pot trials of the 132 cowpea lines tested 10 remained free of emerged parasite stems when challenged by *A. vogelii* collected from Ilonga and Ismani and four were found to be completely resistant in the initial trial in Malawi. Overall these included 13 breeding lines from IITA, the landrace accession B301 and land race TZA 263 collected from Tanzania. (Table 1)

Further screening of 99 of the lines tested in pots was undertaken on infested field sites at Bihawana (Dodoma

Table 1. Line which showed higher degree of resistance to *A. Vogelii* identified by the project at the initial stage of varietal development.

Lines	Tanzania			Malawi	Remarks
	Ilonga	Bihawana	Ismani		
IT99K-573-1	R	R	R	-	Resistance
IT97K-499-8	R	R	R	-	Resistance
IT97K-818-35	R	R	R	-	Resistance
IT97K-819-118	R	R	R	-	Resistance
IT97K-499-38	R	-	R	-	Less resistant
IT99K-7-21-2-2-1	R	-	R	R	Resistance
IT89KD-288	R	-	R	-	Resistance
IT00K-1207	R	-	R	-	Resistance
IT96D-733	R	-	R	-	Resistance
B301	R	R	R	R	Highly resistant
TZA263	R	-	R	-	Less resistant
IT99K-494-6	-	-	-	R	Less resistant
IT99K-1060	-	-	-	R	Less resistant
IT97K-820-18	-	-	-	R	Less resistant
IT03K-378-4	-	-	-	R	Less resistant
IT97K-499-38	R	R	R	R	Highly resistant
IT81D-994	R	R	No test	R	Resistant

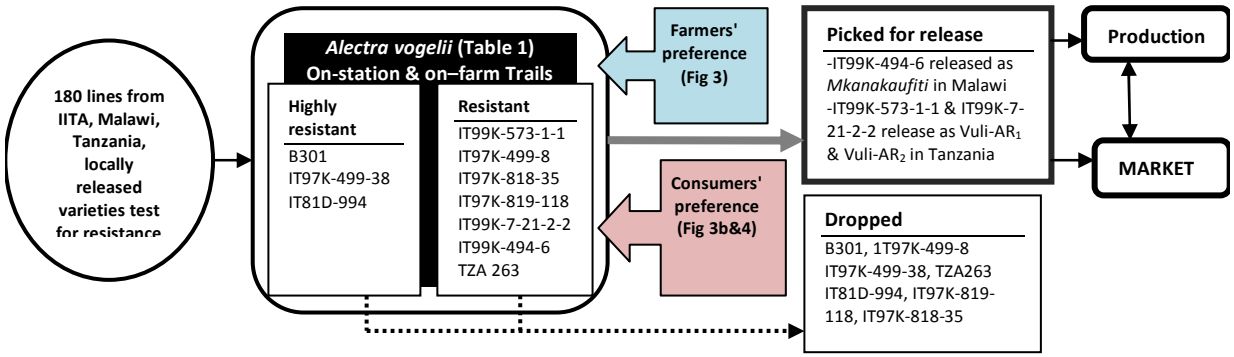

Figure 5. *A. vogelii* market led breeding pathways.

District) and Ismani (Iringa District) in Tanzania. Ten lines remained *Alectra* free. The pot trial in UK was undertaken to check if there is any geographic variation in the virulence of *A. vogelii* on different cowpea genotypes. Of 14 cowpea lines tested. Three cowpeas, IT81D-994, B301 and IT97K-499-38 did not support the emergence of any of the five parasite accessions from Tanzania or Malawi under the conditions of the trial. However the results to date suggest that land race B301 and line IT81D-994 may provide resistance to all the sites where project trials have been undertaken or from where *Alectra* seed used in trials was collected. Only one sample of *Alectra* seed was used from Malawi. Line IT81D-994 has not been tested in the field in either Malawi or Tanzania. A number of lines appear to offer resistance in either Malawi or Tanzania.

As explained above agronomic preference i.e. high yielding, early maturity, resistant to *Alectra* attack, tolerance to insect pests coupled with consumer preferences i.e. large sized seed, white/brown seed coat colour and production of many and tender leaves had to be sought and direct the breeding programme as outlined in breeding pathway described below.

Outcome of *A vogelii* breeding and market preference pathways

Figure 5 below present a pathway used to release varieties which took into consideration the resistance to the parasitic weed signals from the market. With 180 which the project started with in 2006, the screening work remained with 13 very promising lines with respect to resistance to *A. vogelii*. To avoid past failures where

varieties have been released based on key agronomic traits only without taking due consideration to consumers (market), the promising lines were further subjected to farmers and consumers preference tests as explained in Figure 3 and 4 above.

According to perceived pathway, lines such as B301, IT97K-499-38, and IT81D-994 were not selected and recommended for release despite having super resistance against *A. vogelii* because they lacked important traits required by the market. For example line B301 was dropped because it has smallest seed size which is an important trait as far as farmers and consumers are concerned.

The released variety *Mkanakaufiti* and candidate lines IT99K-573-1-1 & IT99K-7-21-2-2 have the seed colours, large sized seeds etc. The two candidate lines have been released as *Vuli-AR*$_1$ and *Vuli-AR*$_2$ respectively. All these varieties have traits liked by consumers hence the market. Based on the demand theory presented in equation (i) and (ii) above, if the released varieties are superior for the market, demand of the same will increase wich will in turn stimulate production at farm level.

CONCLUSION AND RECOMMENDATION

The pathway for developing a market led cowpea production in Malawi and Tanzania has been presented in this paper. Based on the finding it can be concluded that production hence marketing of cowpea depends on availability of varieties which are appealing to consumers/traders. Breeding programme that takes into account on consumer preferences tends to lose potential candidates with respect to agronomic traits (i.e. resistance to *A. vogelii* attack) since these lacks important traits needed by consumers. Since cowpea is slowly becoming as cash crop for resource poor farmers in semi-arid areas of Malawi and Tanzania, stakeholders (consumers) participation determining lines for release offer the best approach as far as modern value chain approach is concern.

This study finally concluded that those lines which are superior agronomically but inferior as far as market traits is concern should be used in a cross breeding programme to donate genes to highly susceptible officially released varieties such as *Fahari, Vuli-*2 and Sudan-1.

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