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## BEAN SEED CONTAMINATION BY PATHOGENS AND CURRENT MANAGEMENT STRATEGIES IN MURANG'A AND KIAMBU COUNTIES

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Citation: Kihara, S.N., Kuria, S.N. Kamau, M.W., Kamau, E.M. and Karanja, D. (2015) Bean seed contamination by pathogens and current management strategies in Murang'a and Kiambu counties. Isutsa, D.K. and Githae, E.W. *Proceedings of the Second Chuka University International Research Conference held in Chuka University, Chuka, Kenya from 28<sup>th</sup> to 30<sup>th</sup> October, 2015.* pp9-pp17.

### ABSTRACT

Good agricultural practices require planting of correct and clean materials. A study to determine bean farming practices and assessment of the importance of seed-borne diseases in common beans in Murang'a and Kiambu Counties was conducted. Evaluation for seed type used and performance of farm-saved and certified seed in farmers' fields and marketing of produce was done in July to August, 2015. Forty farmers per county were involved and 0.5 kg sample of beans was collected from each participating household and tested for pathogen contamination. Only 1% of the farmers used certified seeds and only 5% produced enough to eat and surplus for sale. Over 60% were aware of Arthropod pests but not diseases and seeds; 73.8% did not sort seeds. The common pathogens detected were: *Colletotricum lindemuthianum*, *Fusarium* sp., *Alternaria alternata*, *Penicillium*, spp., *Asperigillius* sp., *Xanthomonas* and *Pseudomonas* spp. These pathogens were prevalent in 1-5% of certified seed. Certified seeds had significantly ( $P<0.05$ ) better weight than farm-saved seeds. Farmers preferred their own saved seed than certified ones, and did not consider importance of seed sorting and use of certified seeds to improve crop health and quality of produce. Farmers need training on good bean farming practices for realization of locked potential. The effect of soil fertility on grain yield of beans needs quick intervention for farmers to realize the importance of inputs.

**Keywords:** Bean farming, Market, *C. lindemuthianum*, *Fusarium* sp., *Alternaria alternata*, *Penicillium* spp., *Asperigillius* sp., *Xanthomonas*, *Pseudomonas* spp.

### INTRODUCTION

Common bean (*Phaseolus vulgaris* L.) is the most important pulse crop cultivated in Kenya. They are ranked second to maize in importance as a major food crop in terms of food security, production and consumption. Beans are the major source of protein, and relatively inexpensive protein compared to animal protein (Kay, 1979), especially in the rural areas where over 80% of the population lives. They have high amounts of essential amino acids e.g. lysine, tryptophane and methionine which are lacking in most staple foods like maize, bananas and cassava with which beans are often consumed. Beans are also rich in carbohydrates and minerals such as calcium and iron. Bean consumption is bound to increase as a result of high prices of animal protein and the increasing population. Besides being a major food crop, beans are sold for cash. Other benefits derived from the crop include its use as green manure and livestock feeds, although these are rarely practiced in Kenya (Mukunya and Keya, 1975). Also, being leguminous, beans harbor *Rhizobium* bacteria which fix free atmospheric nitrogen, thus helping in maintenance of soil fertility.

In Kenya about 380,000 tons of dry beans are produced from an area of about 720,000 hectares annually. The major bean production is in counties in Eastern, Rift Valley, Western and Central regions. Beans in Kenya are important in all agricultural areas except in the lower humid coastal region. In a survey conducted in major bean growing areas beans were found growing in all zones (as defined by Jaetzold and Schmidt, 1983) ranging from upper highland zone to lower midland zones in high potential areas with mean annual rainfall above 1,000mm, medium potential areas with 750 - 1000 mm, and marginal potential areas where rainfall ranges between 500 and 750 mm per annum. In recent years there has been an extension and increase of bean production in marginal areas to which people have migrated due to rising population pressure in the more productive highlands.

In Kenya, bean yields are generally low, ranging from about 900 kg/ha to 2,500 kg/ha (KARI, 1993), although potential exists for higher yields than realized. The national annual dry bean production of about 380,000 metric tons falls far below the projected pulse demand of 749,000 metric tons (National development Plan, 2002-2008). Kenya is not self-sufficient in beans and substantial amounts are imported from Tanzania, Uganda and Ethiopia. Dry bean production which is predominantly by small-scale farmers has been on the decline due to various constraints which include unfavorable climatic conditions (e.g. drought), low soil fertility, poor cultural practices, lack of suitable varieties, inadequate bean production technology transfer, inadequate seed dissemination systems, lack of market information and infestation by arthropod pests (including bean stem maggot (beanfly), bollworms, aphids, systates weevil and nematodes) and diseases (fungal, bacterial and viral diseases) (Mukunya and Keya, 1975), with diseases causing more damage than insect pests (Anon., 1985). A wide range of fungal, bacterial and viral diseases has been recorded in Kenya (Allen, 1995). Some of the major fungal diseases include angular-leaf blight (*Phaseoliopsis grioseola*), anthracnose (*Colletotrichum lindemuthianum*), leaf rust (*Uromyces appendiculatus*) and root rots caused by a variety of fungal pathogens like the Fusarium root rot. Also viral diseases and nematodes infestation (by e.g. bean common mosaic virus and root knot nematodes respectively) are of great concern.

Most bean diseases are spread by seed, either as internal infections or external contamination. Consequently their incidence is aggravated by sowing of seeds saved from previous harvests. Among the seed-borne bean diseases, common bacterial blight and halo blight cause considerable damage in some bean-producing areas of Kenya (Acland, 1971; Mukunya and Keya, 1975). Common bacterial blight caused by *Xanthomonas campestris* pv. *phaseoli* (Smith) Dowson occurs in Kenya in medium altitude ecologies encompassing districts such as Meru, Kitui, Machakos, Kakamega, Embu, Trans Nzoia and Murang'a (Muthangya, 1982). Halo blight caused by *Pseudomonas syringae* pv. *phaseolicola* (Burk.) Young et al) appears frequently in cool, high-rainfall areas (Kinyua and Mukunya, 1981).

Both the common and halo blight pathogens survive between cropping seasons on seeds or on diseased crop residues (Scuster and Coyne, 1974; Sherf and Macnab, 1986; Origa, 1991). In a previous study level of contamination by *Xanthomonas* sp in grower's seed sampled in Central and Eastern provinces in Kenya ranged between 9% and 24%; while *P. syringae phaseolicola* was the main contaminant on the samples originating in Kisii, Nyeri and Meru districts (Mukunya and Keya, 1975).

Some of the diseases are widespread in distribution while others are confined to some specific environments. The notion of geographical confinement of bean diseases may no longer be valid given the seed-borne nature of many pathogens (Acland, 1971; Mukunya and Keya, 1975). Hence most of the major diseases occur almost wherever the crop is now cultivated (Allen, 1995). New bean seed pathogens might also not be ruled out especially with the current movement of food commodities across the borders between eastern African countries. For instance some of other bacterial diseases of dry beans, unknown to occur in Kenya but reported elsewhere, include bacterial brown spot caused by *Pseudomonas syringae* pv. *syringae*, wildfire caused by *Pseudomonas syringae* pv. *tabaci*, and bacterial wilt caused by *Curvobacterium flaccumfaciens* pv. *flaccumfaciens* (Sherf and Macnab, 1986).

However, little is known on occurrence and yield losses due to bean diseases in some high altitude production areas of Kenya. In countries-such-as- the U.S.A., yield losses as high as 43% and 40-60% attributed to halo blight and common blight, respectively, have been documented (Sherf and Macnab, 1986). Also there is no information on levels of contamination of seed bean by bean pathogens and factors influencing development of the diseases.

It is imperative to obtain knowledge on aspects of bean diseases to enable formulation of effective disease management strategies. Seasonal occurrence and prevalence of various diseases should also be determined. Farmers are also known to use bean seeds from the open markets selected from previous crops. These may be the main source of various diseases. The suitability of such seed for planting need to be assessed. Therefore, the objective of this study was to assess the extent of farmer's bean seed contamination by seed-borne diseases (quality of farm-saved seeds in small-scale farms) and the current disease management strategies employed by farmers in Kiambu and Muranga Counties.

## **METHODOLOGY**

### **Summary**

Incidence, severity, distribution and sources, of seed borne bean diseases were carried out. Bean seeds were sampled from grower's stores and assessed for, bean seeds weight, physical discoloration and contamination by various pathogens. The pathogens were isolated from the samples using selective media and identified by standard laboratory assays.

### **Questionnaire and Collection of Seed Samples**

Small scale farmers were randomly identified in Murang'a and Kiambu Counties in July to August 2015. A designed questionnaire was used to capture information on over 70 respondents' social-economic factors. The back ground details included gender, marital status, age, level of education and household type (male or female headed). Farming practice information captured included farm size, main source of seed, whether they treat seed before planting, planting system used (mono-crop or intercropping). Also enquired is whether the yield per acre realized, whether they sort before storing and what they consider during sorting and how much they had found to be spoilt during the previous season.

### **Seed Health Testing in the Laboratory**

Each participating household had ½-1kg seed samples of common beans collected. The samples were subjected to thorough mixing and in the laboratory three sub-samples each of two hundred (200) seeds from each sample was taken randomly by spoon method (ISTA, 1993). One set of sub-sample was subdivided into lots of 50 seeds and each weighed separately. The 50 seed lots of seeds from the same sub-sample were separated into discolored and clean seeds and percentage of each category determined. The other lot was subjected to seed pathological infection testing by plating on selective media in sterile disposable petri-dishes. There were five seeds per petri-dish replicated three times. These were incubated for seven days at room temperature (20-24°C) after which the individual seeds were examined under stereo microscope. Fungal identification was confirmed by examining spores under a compound microscope. The indirect method (Mortensen, 1995) was used to detect the bacteria species present. The occurrence and frequency of each fungal and bacterial pathogen were recorded. The third lot was used to evaluate germination. This test was conducted in the laboratory and on sterilized filter paper inside service sterilized Petri dish. For every sub-sample of 200 seeds, 25 were drawn and tested, each divided into 5 seeds and replicated 5 times. Data was analyzed using a socio-statistical package, SPSS.

## **RESULTS**

### **Social and Seed Quality Results**

About 70 farmers were interviewed and the highest number of respondents who were involved in the cultivation of the bean crop as per this study was women, 67.1% in both Mirang'a and Kiambu

counties (at 34.3% and 32.9 respectively). Of these 84% were married, 2.9% being single youth while the rest were either single or widowed parents and majority (70%) were between 41 and 70 years of age, with those at between 51 and 60 years leading in number (24.6%) and primary education dominated (57%) as the highest education level (Table 1). About 80% households were male headed and decision to grow beans was mainly made by women. Over 70% of the farmers were aware of the cultivation of the crop, but health of the seed was not given any attention. Most farmers (78.5%) in the study area used informal, uncertified seed, 51% from market while 11.4% and 15.7% were from other farmers and own saved respectively. Only 21% who used certified seed of whom 8% were from Thika sub-county where they were provided certified materials, on loan, by the county government during the previous season. However the so called certified, in some areas, were the improved lines which are being recycled sometimes becoming like local material. Most farmers (82.9%) intercropped beans with other food crops and only 11% who claimed to treat seeds before planting and these happen to be from Thika (Table 2).

Most of the farmers (67.1%) had an average land of <3 acres, of which, over 50% yielded below 250 kg/ha which is far below the African potential of 600-900kg/ha. Gatundu North Sub-county had the majority (11.1%) in this category while Thika Sub-county had the largest number (6.4%) of those farms with yield rate within the lower and upper potential limits. Over 78% farmers reported not to have any spoiled bean produce at harvest while 9.1%, 5.5% and 7.3% reported 1-5kg, 6-10 and >10kg spoilage. Among the respondents 58.9% sorted their produce before storage 74% claiming to sort for pests and diseases while the rest sorted for other factors like size color and variety (Table 3).

**Table 1:** Gender, marital status, level of education and age of respondent aspects of common bean growers in Murang'a and Kiambu Counties in 2015

Gender of respondent			Marital status			Level of education			Age in years		
Gender	HHs	%	Marital status	HHs	%	Highest level	HHs	%	Range	HHs	%
Male	23	32.9	Single	2	2.9	Primary	40	57.1	<30	3	4.3
Female	47	67.1	Married	58	84.1	Secondary	21	30	31-40	12	17.3
			Single with children	3	4.3	Tertiary	6	8.6	41-50	13	18.8
			Single (Widow/Widower)	6	8.7	None	3	4.3	51-60	17	24.6
									61-70	16	23.2
								71-80	6	8.7	
									>80	2	2.9
Total	70	100		69	100		70	100		66	100

**Table 2:** Dry bean farmers using different planting systems, using seed material from variable sources and either treat or do not treat seeds before planting beans in Murang'a and Kiambu Counties in 2015

Aspect		Murang'a	Kiambu	P value
Planting System	Mpnocropping	3	10	0.021
	Intercropping	30	28	
Main source of planting material	Other farmers	8.6	2.9	0.012
	Government/NGO	8.6	12.9	
	Own saved seed	4.3	11.4	
	Market	24	27.1	
Do you treat bean seeds before planting	Yes	10.9	0	0.004
	No	37.5	57	

**Table 3:** Percentage of dry bean farmers using different planting systems, using seed material from variable sources and either treat or do not treat seeds before planting beans in Murang'a and Kiambu Counties in 2015

Aspect		Murang'a	Kiambu	P value
Total Spoilt in Kg (%)	0 kg	20	58.2	0.000
	1-5 Kg	9.1	0	
	6-10 Kg	5.5	0	

	>10 kg	7	0	
Sorting before storing	No	10	28.6	0.003
	Size	8	10	
What do you Sort For?	Size	8	10	0.049
	Pests/Diseases	46.0	28	
	Dirt/variety, etc	0	8	

**Table 4:** Percentage of dry bean farmers whose bean samples had the indicated weight per 50 seeds the sown quantity of clean seed for bean growers from Murang'a and Kiambu Counties in 2015

Aspect	County	% of HH with the indicated number of bean seeds in the aspect					P value
		≤10gm	11 -15 gm	>15-20 gm	20-30 gm	Above 30 g	
Weight of 50 seeds	Murang'a	3	20.8	17.8	9	0	0.051
	Kiambu	1	14.9	14.9	20	1	
% Clean seed		<20%	21-40%	41-60%	61-80%	81-100%	0.001
	Murang'a	1	3	6	26	14	
	Kiambu	1	0	3	12	36	

**Table 5:** Percentage of dry bean farmers whose bean samples had the indicated No. of colonised seed, No. of dead seed, No. of germinated seed and No. of colonised shoot and/or root for bean growers from Murang'a and Kiambu Counties in 2015

Aspect	County	% of HH with the indicated number of bean seeds in the aspect					P value	
		0	1	2	3	4		5
No of colonised seed	Murang'a	29	6.9	2.9	3	3.9	2.9	0.354
	Kiambu	34	8.8	3.9	0	1	2	
No of dead seed	Murang'a	32	6.8	1	2	3.9	2.9	0.289
	Kiambu	42	3.9	1.9	0	1	2.9	
No of germinated seed	Murang'a	1.9	2.9	2	1.9	8.9	31	0.071
	Kiambu	5	0	0	0	6	42	
No of colonised shoot and /or root	Murang'a	16.5	12.6	7.8	5.8	2.9	2.9	0.01
	Kiambu	36.9	5.8	2.9	2.9	1.9	1	

Almost all the respondent farmers had a slight knowledge of bean arthropod pests but majority were not aware of bean diseases. None of the above 70 farmers was aware of seed-borne diseases and quality and this expresses the need for training. However, results of quality assessment of the bean samples from the farmers nearly correlated with farmers findings. About 50% of the samples were found to be over 80% clean and only 2% having less than 20% clean seeds. The weight of 50 seed exceeded 15g in more than 60% of the samples of which 8% was from certified seed planted at Thika and had significant difference ( $p < 0.05$ ) (Table 4). From laboratory assays 64% of the samples did not grow any micro-organism while as some seeds rotted completely, 74% of them, whether colonized with fungi (or bacteria) or not, did not rot (Table 5). About 10.7% had, each, only 1 seed dead while only 5.8% had all five seeds dead. In germination test, each of 72% samples had all seeds germinated and only 6.8% had zero germination which coincided closely with materials planted in Thika. Among those which germinated, some had the shoot and/or root infected with the emerging organisms. However, 53.4% of the samples had zero infection while only 3.9% had all seeds infected. For the isolated micro-organisms, although were found in samples from all the sub-counties, present in 69.1% samples and absent in 30.9% samples. *Fusarium* spp were present in 66.2% of the samples while *Alternaria* spp were isolated in 65% samples but was absent in five sub-counties *Xanthomonas* spp and *Pseudomonas* spp bacteria were both isolated from 6% and 4.4% samples from 4 and 3 sub-counties respectively (Table 6).

*Colletitrichum* spp occurred in all sub-counties, it was absent in 66% samples. Also isolated was *Penicillium* spp which were absent in 67.6 samples and two counties, Thika and Kiharu. *Aspergillus* spp

**Table 6:** Percentage of dry bean farmers whose bean samples had the indicated pathogens isolated for bean crop growe in Murang'a and Kiambu Counties in 2015

Pathogen	Situation	Murang'a	Kiambu	P. value
Colletotrichum spp	Absent	31	34	0.028
	Present	15.5	17.5	
Penicillium spp	Absent	32	37	0.402
	Present	16.5	13.6	
Aspergillus spp	Absent	25.2	12.6	0.004
	Present	23.3	38.8	
Fusarium spp	Absent	12.6	24.3	0.058
	Present	35	27.2	
Alternalia spp	Absent	45.6	50.5	0.28
	Present	2.9	1	
Xanthomonus spp	Absent	44.7	50.5	0.149
	Present	3.9	1	
Pseudomonas sp	Absent	44.7	49.5	0.36
	Present	3.9	1.9	

## DISCUSSION

Over 90% of the farmers were aware of the cultivation of the common bean crop in both Murang'a and Kiambu Counties but more women (52.4%) played the role of growing the crop (Table 1). This indicated that although majority of farmers were couples in men headed households women made most of the decisions as far as bean crop is concerned and did most of the activities like seed sorting, planting, weeding and harvesting. Resources to perform important functions in agriculture were generally controlled by men and showed that male farmers were more interested in cash crop while subsistence crops were left for the women farmers. Age and level of education is not a hindrance to improving farmers bean farming skills through training since majority are middle aged and literate although the youth needs to be more sensitized. The small sizes of land have lead over-cultivation and informal practices hence the low yield. This calls for training of good agricultural practices for increased productivity. Many of the farmers desired certified seeds and those of Thika who had been provided with the material, though on loan, were making a good produce with less constraints. They accepted to have made some profit which other farmers using informal seed and traditional practices never made.

Pathogens for important seed-borne diseases such as Anthracnose, Halo and Common blights were detected on the farm-saved seed of common beans in most the seed categories and indication that farmers were not safe from these diseases since they were not competent in distinguishing infected from non-infected seed. Some of the diseases were seed-borne as well as debris and soil-borne and all may affect seed quality in one-way or another. The presence of storage fungi, *Penicillium*, *Asperigillius* spp and *Fusarium* spp and also other contaminating fungi may have a role in reducing the quality of the seed and could also have inhibited the growth of fungal pathogens. This also showed that the farmers in Murang'a and Kiambu sorted their seed for planting not basing on the diseases, hence lacked knowledge on the health and quality of the seed.

The participation of the farmers and extension officers during the survey and the queries raised about certified seeds and other practices, during the interview, showed that they needed more knowledge on seed health and quality for the common bean and other crops. They appreciated the fact that they could visually identify some of the diseases on infected seed and this will be useful to them in future. The farmers were able to see the importance of seed quality and germination, seed sorting, use of clean seed and also use of certified seed to improve on weight of their seed and hence better market for the surplus.

## CONCLUSION

The study showed that bean farmers are not making any profit and lack knowledge on the use of clean seed, an indication that more training on good seed production procedures and ways of improving farm- saved seed through sorting is required. Some farmers are now asking for certified seed to

achieve high yields and improve on the bean produce quality. However, certified seed though good, will require high initial capital which may not go well with resource poor farmers. To give new materials without prior training may be like the proverbial ‘new wine on old skin’. They require training in order to be able to take care of the seeds. There is need to educate these farmers on the use of clean seed free from seed-borne diseases. This would earn them an income, reduce poverty hence improve their living standards. Farmer advisory and extension on health and quality of seed is the way forward on farm-saved seeds, while certification is value adding and technology sourcing option to farmers for improved productivity. This information formed a base line for future research and will assist in the determination of tolerance levels; a lead factor in advising small-scale farmers on the management strategies of seed-borne diseases in common beans and also other seed crops. Farmers need more training on good bean farming practice for them to realize the locked potential. The effect of soil fertility on grain yield of beans needs quick intervention for farmers to realize the importance of inputs while cultivating beans. Farmers seed quality using ISTA methods, greenhouse and field performance and disease incidence in farmers field during bean flowering and/or podding needs to be evaluated. Further studies are required on the effect of seed sorting on yield of farm saved- seed.

#### ACKNOWLEDGEMENT

The authors acknowledge support by CIAT and KALRO and the Ministry of Agriculture, Murang’a and Kiambu Counties for their participation in the study. We also appreciate Ag Center Director, KALRO Kandara and Ag Director Horticulture Research Institute for their support and encouragement and Lillian G. Kamau, of Mycology Laboratory KALRO Kandara for excellent technical support.

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