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ASSESSING THE CONTRIBUTION OF DOLICHOS BEAN (*Lablab purpureus* L. (Sweet)) TO FOOD SECURITY IN A CHANGING CLIMATE IN KENYA

Grace N. Kamotho[1*], Miriam G. Kinyua[2] and Reuben M. Muasya[3]
[1]Karatina University, P.O. Box 1957-10101, Karatina, Kenya
[2]University of Eldoret, P.O.Box, 1125, Eldoret, Kenya
[3]South Eastern Kenya University, P.O. Box 170-90200, Kitui, Kenya

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ABSTRACT

Lablab pupureus (L.), is a multipurpose drought tolerant legume which is considered as a minor crop in Kenya, hence, it is underutilized. In Kenya there are few known Lablab genotypes for specific environments. Choice of genotypes to grow is based on colour preference and seed availability, thus low yields are obtained. To assess the status of Lablab production in Kenya, a baseline survey was conducted in Lablab growing localities. A disproportionate stratified sampling was used and a questionnaire was administered to 108 respondents from diverse Lablab growing regions of Kenya. Performance of Lablab genotypes under different environmental conditions was also evaluated. Field trials of forty five (45) accessions of Lablab collected from Rift Valley, Eastern, Coast and Central regions of Kenya were established in three locations with different agro-ecological environments; (Nakuru, Uasin Gishu and Bungoma). The 45 accessions and three environments were factorially combined and replicated three times in a randomized complete block design (RCBD). Results from the survey indicate that most farmers (84.3%) grew Lablab in small acreage of less than 1.0 acre, and only 44.4% of the respondents used the improved Lablab cultivars which were obtained from the Ministry of Agriculture or research stations. Majority (88%) preferred Lablab to common beans and all respondents noted that Lablab fetched more income per unit quantity than common bean. All respondents utilized Lablab dry beans as food. The crop was also utilized as a livestock feed especially during the dry season when no other crops are in the farms by 51.9% of the respondents while 25% used it in conservation agriculture and for soil erosion control. About 20.4% of farmers used the leaves and green pods as vegetables. The study identified accessions that are suitable for different agro-ecological zones. In conclusion, Lablab is a crop that is climate resilient and contributes to food security in communities that grow it. It is recommended that dolichos should be promoted in Kenya as a climate change adaptation measure and for enhancing food security.

Keywords: Dolichos bean, accessions, food security, agro-ecological zones.

1. INTRODUCTION

Lablab pupureus (L.) Sweet, synonym *Dolichos Lablab* (L.), belongs to the family Fabaceae. It is a good source of proteins, minerals and vitamins. In India and China, the complete plant is edible [1]. Young leaves are eaten raw in salads and older leaves are cooked like spinach. Flowers are eaten raw or steamed. The large starchy root tubers can be boiled and baked. The immature and dried seeds can be boiled and fried. Both the leaf and seed of dolichos bean are rich in proteins. Immature pods contain 82% water, 4.5% protein, 2.7- 4.2% crude lipid, 10%

carbohydrates and 2% cellulose. Mature seeds contain 9.5% water, 20 - 25% crude proteins, 0.8% fat, 63 - 66% carbohydrates and 5 - 7 % dietary fibre [1]. In Asia the mature seeds are made into tofu (a curd obtained by compressing the dolichos beans after soaking, de-hulling, partly cooking and adding vinegar) and tempeh (fermented tofu). It is also useful as a cover crop and for forage. Its dense green cover during the dry season protects the soil against the action of the sun's rays and decreases erosion by wind or rain. As green manure, it provides organic matter and minerals. It also fixes nitrogen into the soil thereby improving crop yields. Due to its drought tolerance, dolichos bean grows in a diverse range of environmental conditions. Its multipurpose uses make it an important species globally [1].

2. MATERIALS AND METHODS

Baseline Survey on Dolichos Bean Production Constraints

A baseline survey was carried out in Lablab growing areas of Kenya. The survey involved examining secondary data at the Ministry of Agriculture county offices, oral interviews with agricultural extension staff and farmers during field visits. A number of dolichos growing regions in Kenya were selected and a disproportionate stratified sampling was used as illustrated by [2] in order to obtain a representative sample. The strata used were counties and their agro-ecological zones. Thus, data from Coastal region of Kenya was taken from Lamu-Mpeketoni which is the major Lablab growing area and falls under agro-ecological zone II (Lowland). In Eastern region of Kenya data was taken from Mwingi-Central and Mwingi-Migwani, Machakos-Kalama and Machakos-Kathiani, Mbeere-Siakago (agro-cological zone III) and Meru-Central, Meru-Abothogushi and Meru-Mihiriga-Mieru which is in agro-ecological zone II (Upper highland). In Central region of Kenya, data was taken from Makuyu, Maragwa-Ridge, Kakuzi and Thika Municipality (agro-ecological zone II (Upper highland)) while in Riftvalley region of Kenya data was taken from Nakuru-Lare, Naivasha and Bahati which are in agro-ecological zone II. A total of one hundred and eight (108) respondents were interviewed.

Performance of Dolichos Bean under Different Agro-Ecological Environments

Field trials of forty five (45) accessions of Lablab collected from Rift Valley, Eastern, Coast and Central regions of Kenya were established in three locations with different agro-ecological environments; Nakuru-Kenya Agricultural and Livestock Research Organization (KALRO)-Njoro farm, Bungoma-Mabanga Agricultural Training Center (ATC), and Uasin Gishu-University of Eldoret farm. The forty five accessions and three environments were factorially combined and replicated three times in a randomized complete block design (RCBD). Data considered included; days to 50% flowering, duration of flowering, days to 90% mature pods, number of pods per raceme, number of pods per plant and racemes per plant, seeds per pod, 100 seed weight and seed yield per plant.

3. RESULTS

Baseline Survey on Dolichos Bean Production Constraints

Table 1.1 indicates that most farmers (84.3%) grew Lablab in small acreage of less than 1.0 acre while 15.7% grew Lablab in acreage more than 1.0 but less than 2.0 acres. The bigger acreage of Lablab was found in Lamu where it has effectively replaced bean in the diet and is commonly grown by a large number of farmers. None of the farmers grew Lablab in acreages above 2.0

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acres. This owes to the fact that in areas where Lablab is popular especially in Lamu, farmers have small parcels of land, not more than 2.5 acres per household.

Only 44.4% of respondents grew the improved Lablab sourced from the Ministry of Agriculture (cultivars DL1002 and DL1009 from Kenya Agricultural and Livestock Research Organization, Katumani). However, a big percentage of farmers (56%) grew the local Lablab cultivars. Although all the respondents encountered insect pest problems, only 44% attempted some control options while only 4.6% attempted to control diseases. A few farmers 2.8% used either fertilizer or manure at planting while no farmer top dressed the crop. However, respondents argued that since Lablab is in the family of common beans it was expected to add fertility to soil and therefore it was not necessary to use fertilizers. Most farmers (41.7%) grew Lablab as an intercrop while 34.3% and 25% of the respondents grew it as a pure stand and on terraces respectively. The practice of intercropping Lablab with maize was common in Lamu, Maragwa and Thika.

Table1.1 Farming practices used by respondents

Crop husbandry practices by farmers	No. Resp	% Resp	Crop husbandry practices by farmers	No. Resp	% Resp
Farmers who grew Lablab bean as pure stand	37	34.3	Farmers who encountered disease incidences	34	31.5
Farmers who grew Lablab bean as an intercrop	45	41.7	Farmers who controlled disease	5	4.6
Farmers who grew Lablab bean on terraces	27	25.0	Grew Lablab bean in < 0.5 acres	15.7	14.5
Farmers who used fertilizer at planting	2	1.9	Grew Lablab bean between 0.5 and 1.0 acres	62.3	57.7
Famers who used manure at planting	1	0.9	Grew Lablab bean between 1.0 and 2 acres	30.02	27.8
Farmers who top dressed Lablab bean	0	0	Grew Lablab bean in > 2 acres	0	0
Farmers who encountered insect pest attack on Lablab bean.	108	100	Farmers who grew improved Lablab cultivars	48	44.4
Farmers who controlled insect pests	48	44.4	Farmers who grew local Lablab cultivar	60	55.6

Key: No. Resp – Number of respondents;
% Resp – Percentage respondents

Utilization of dolichos bean in Kenya

All the respondents (100%) utilized Lablab dry beans as food (Fig.1.1). Of the respondents, 51.9% utilized it as a livestock feed while 25% used it in conservation agriculture. The practice of using Lablab in soil erosion control was common in Mbeere, Mwingi and

Maragwa regions of Kenya. A few farmers (16.7%) used the leaves as vegetables while only 3.7% consumed the green pods as vegetables especially during the dry seasons.

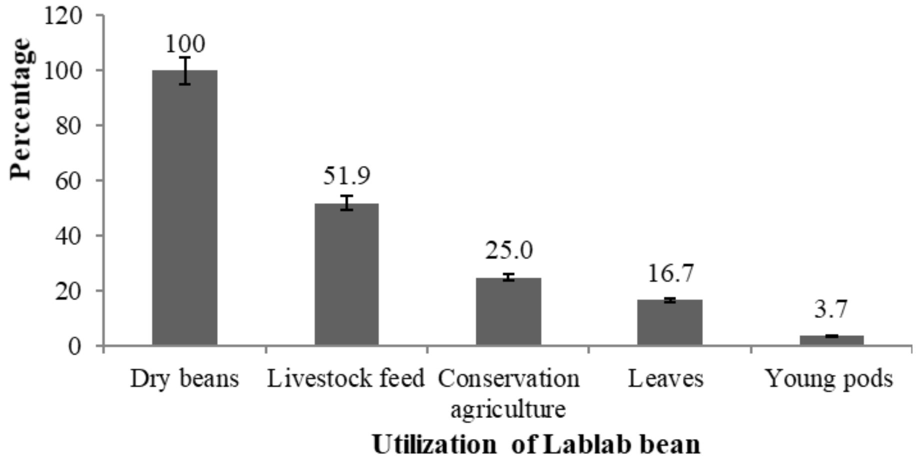

Fig.1.1 Utilization of dolichos bean by respondents

Source of dolichos bean seed

Only 44.4% of the respondents obtained seeds from the Ministry of Agriculture (Fig. 1.2). This corresponded to number of farmers who used the improved Lablab cultivars (Table 1.1). Other farmers (35.2%) saved seed after harvesting to plant in the following season while 9.3% purchased seed from the market and 11.1% obtained seed from neighbours.

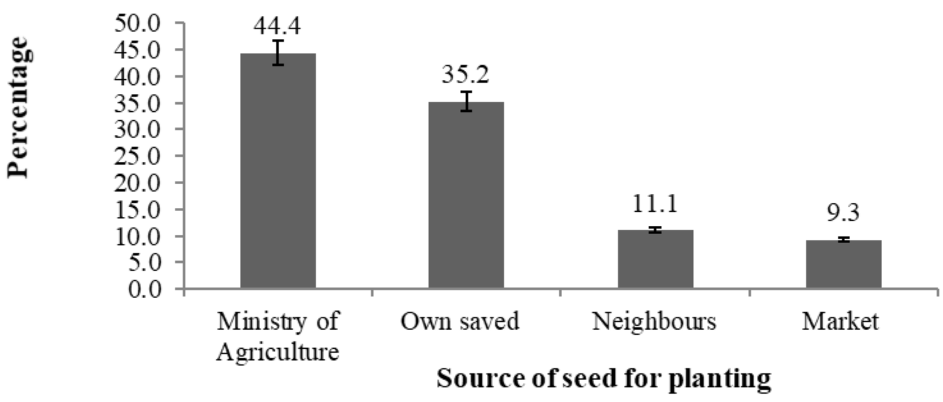

Fig.1.2 Source of dolichos bean seed

Technology development in dolichos bean

Majority of the respondents (73.1%) preferred a variety that is insect pest and disease resistant since this is the main challenge in Lablab production. However, 12% of the respondents preferred a variety that has a better taste. Other respondents (5.6%) preferred a variety that is high yielding while 3.7% of growers favored a determinate variety that matures early. A small percentage (2.8%) observed that they preferred a variety that takes a short period to cook.

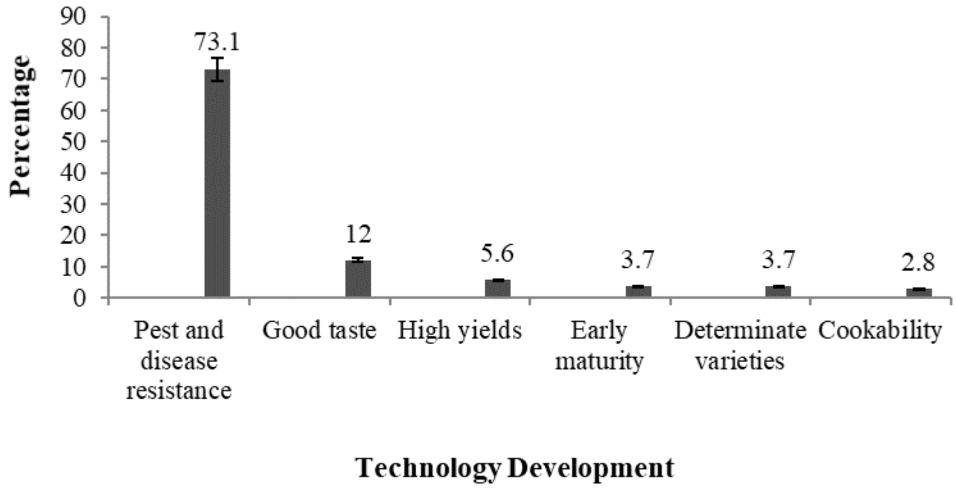

Fig.1. 3 Traits for improvement in dolichos bean

Performance of Dolichos Bean Under Different Agro-Ecological Environments

The three sites were significantly different in seed yield per plant (Table 1.2). However, accessions collected from same geographical region recorded yields that had no significant differences. Seed yield per plant varied from 17.7g to 203.5g. The least seed yield per plant was recorded in Bungoma-Mabanga ATC farm while the highest yield per plant was realized in Nakuru-KARLO, Njoro farm. In general, Nakuru recorded higher yields in all the accessions while Bungoma gave the least yield per plant in all the accessions. Uasin-Gishu ranked number two in yield per plant. The best accession in Nakuru was 36 with a seed yield of 203.5g/plant. In Uasin-Gishu, the best accession was also 36 with a seed yield of 157.05g/plant while in Bungoma, accession 7 had the highest seed yield with 95.07g/plant.

Generally, accessions collected from Lamu perfomed better in Bungoma than other accessions and recorded an average yield of 95g/plant (Table 1.2). However, accession 36 (collected from Nakuru-Bahati) also recorded a high seed yield of 92.85g/plant in Bungoma. Accession 36 was the best performer across all the sites. Other accessions that recorded high seed yield per plant across the three sites were 22 and 23 (sourced from Maragwa-Makuyu) that recorded a seed yield of 188.1g/plant and 188.0g/plant respectively in Nakuru. In Uasin-Gishu, both accessions (22 and 23) obtained a seed yield of 124.19g/plant. In Bungoma accession 22 recorded 85.28g/plant while 23 obtained 85.25g/plant.

All accessions irrespective of places of collection recorded a shorter period of maturity in Bungoma while in Nakuru, all accessions took a long period to mature (Table 1.2). In Uasin-Gishu accessions were not significantly different from Nakuru in maturity period. In general, accessions collected from Lamu had the least days to maturity with a mean range of 117.8 days to 118.0 days after sowing. Accessions 36 (collected from Nakuru-Bahati), 21 (collected from Machakos-Yatta) and 39, 40, 41, 42, 43, 44, 45 (collected from Mwingi) also recorded a short period to mature of about 120 days. Accessions 22 and 23 (collected from Murang'a-Makuyu), 24, 25, 26, 27 and 28 (collected from Thika) ranked third as regards maturity period which was about 147 days after sowing (Table 1.2).

Table 1.2 Yield and days to maturity of dolichos bean accessions across the three environments.

Accession	Seed yield per plant				Days to maturity			
	Nakuru	Uasi-Gishu	Bungoma	Mean across sites	Nakuru	Uasin-gishu	Bungoma	Mean across sites
1	138.1	112.31	95.05	115.2a	123.3	122.3	108.7	118.1a
2	138.0	112.29	95.05	115.1a	123.3	122.7	108.3	118.1a
3	138.1	112.28	94.99	115.1a	123.7	122.3	108.7	118.2a
4	138.0	112.29	94.98	115.0a	123.3	122.7	108.3	118.1a
5	138.5	112.28	95.04	115.1a	123.1	122.4	108.3	117.9a
6	138.3	112.27	95.01	115.3a	123.3	122.3	108.7	117.8a
7	138.2	112.29	95.07	115.2a	123.7	122.1	108.7	117.9a
8	138.1	112.28	94.98	115.1a	123.4	122.3	108.3	118.0a
9	138.1	112.28	95.03	115.1a	123.3	122.7	108.7	118.2a
10	138.0	112.27	95.05	115.0a	123.7	122.3	108.7	118.2a
11	138.0	112.28	94.99	115.0a	123.4	122.3	108.3	118.0a
12	138.1	112.28	95.04	115.1a	123.3	122.4	108.7	118.1a
13	138.0	112.29	95.01	115.0a	123.3	122.3	108.3	118.0a
14	63.2	51.62	35.06	50.0b	192.6	191.3	176.3	186.4b
15	63.1	51.59	35.03	49.9b	192.7	190.7	176.7	186.2b
16	63.2	51.41	35.01	49.8b	192.5	190.7	176.3	186.2b
17	63.1	51.61	35.02	49.9b	192.3	191.3	176.7	186.4b
18	56.0	40.88	30.04	42.3b	192.1	191.3	176.3	186.2b
19	56.1	40.87	30.22	42.4b	192.3	190.7	176.3	186.1b
20	56.0	40.88	29.98	42.3b	192.7	190.3	176.7	186.6b
21	75.1	63.51	41.42	60.0c	126.3	125.7	111.3	121.1c
22	188.1	124.19	85.28	132.5d	153.3	152.7	136.7	147.4d
23	188.0	124.19	85.25	132.5d	153.7	152.3	136.3	147.5d
24	181.3	121.30	77.95	126.8e	153.3	152.7	136.7	147.6d
25	181.4	121.30	77.94	126.9e	153.7	152.3	136.7	147.7d
26	181.3	121.29	77.92	126.9e	153.7	152.3	136.3	147.4d
27	181.3	121.28	77.93	126.6e	153.3	152.3	136.7	147.4d
28	181.4	121.30	77.93	126.8e	153.7	152.7	136.3	147.6d
29	173.7	113.77	68.42	118.7f	158.3	157.7	141.7	152.2e
30	173.8	113.77	68.43	118.6f	158.7	157.7	141.7	152.4e
31	181.5	120.98	85.61	129.4g	158.3	157.3	141.3	152.0e
32	181.4	120.98	85.66	129.3g	158.3	157.3	141.3	152.0e
33	153.6	105.81	73.69	111.1h	172.7	172.3	157.7	167.6f

34	153.7	105.80	73.70	111.1h	173.3	172.7	157.3	167.6f
35	153.6	105.81	73.71	111.0h	172.7	172.3	157.3	167.4f
36	203.5	157.05	92.85	151.1i	125.7	124.7	111.7	120.0ac
37	23.1	19.14	17.70	19.9j	197.3	195.7	172.7	189.6g
38	23.0	19.15	17.69	19.7j	196.7	195.3	172.7	188.2g
39	119.2	96.37	64.84	93.5k	126.3	125.7	111.7	120.9ac
40	119.2	96.10	64.49	93.3k	125.7	125.3	111.3	120.4ac
41	119.1	96.07	64.50	93.2k	126.3	125.7	111.6	120.9ac
42	119.2	96.06	64.48	93.3k	126.7	125.3	111.3	120.8ac
43	119.1	96.05	64.50	93.4k	126.3	125.7	111.6	120.9ac
44	119.2	96.04	64.49	93.3k	125.7	125.3	111.3	120.4ac
45	119.1	95.98	64.72	93.3k	126.3	125.3	111.7	120.8ac
Range	**180.5**	**138.2**	**77.4**	**107.2**	**74.2**	**73.6**	**64.4**	**68.6**
Min	**23.0**	**19.0**	**17.7**	**19.7**	**123.1**	**122.1**	**108.3**	**117.8**
Max	**203.5**	**157.2**	**95.1**	**126.9**	**197.3**	**195.7**	**172.7**	**186.4**
Mean	**129.54**	**96.93**	**70.60**	**99.02**	**149.06**	**147.80**	**133.51**	**143.45**
LSD (0.05)				**2.17**				**2.93**
SED				**0.110**				**0.473**

Key:
Columns having same letters are not significantly different at P≤0.05.

Environment in which dolichos bean was grown had a significant effect on yield and yield related characters such as days to flowering, duration of flowering, days to mature pods, pods per raceme, racemes per plant, pods per plant and seeds per pod (Table 1.3). Nakuru was overall the best in terms of Lablab accessions performance. The least in performance was Bungoma which recorded the lowest values for all characters evaluated. Nakuru and Uasin-Gishu were not significantly different in days to flowering, duration of flowering and days to mature pods.

Table 1.3 Effect of environment on mean yield and yield related characters of Dolichos Bean

Site	**DaF(days)**	**DuF(days)**	**DMP**	**PR**	**RP**	**PP**	**SP**	**100 SWT(g**	**SY (g)**
Nakuru	102.126a	25.637a	149.06a	8.674a	11.305a	113.374a	3.727a	26.225a	129.54a
Uasin-Gishu	102.037a	25.652a	147.80a	7.944b	9.694b	91.704b	3.187b	25.721b	96.93b
Bungoma	92.193b	21.993b	133.51b	7.319c	8.582c	78.367c	2.990c	26.243c	70.60c
Grand mean	**98.79**	**24.42**	**143.53**	**8.00**	**9.86**	**94.48**	**3.30**	**26.06**	**99.02**

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LSD (0.05)	**0.14**	**0.14**	**2.93**	**0.02**	**0.50**	**0.16**	**0.017**	**0.62**	**2.17**
C.V (%)	**0.6**	**2.4**	**0.4**	**0.9**	**2.4**	**0.7**	**2**	**0.4**	**0.1**

Key: Columns having same letters are not significantly different at P≤0.05; DaF- Days to flowering; DuF - Duration of flowering; DMP - Days to mature pods; PD - Pods per raceme; RP - Raceme per plant; PP - Pods per plant; SP - Seeds per pod; 100SWT - 100 Seed weight; SY - Seed yield per plant; g-grams.

4. DISCUSSION

Baseline Survey on Dolichos Bean Production Constraints

From the responses on production practices, it was evident that the low Lablab yield obtained by farmers was as a result of lack of disease and insect pest control, lack of fertilizer usage at planting and top dressing stages, use of poor quality seed, lack of seed dressing at planting and use of low yielding local cultivars. Main reason given by farmers for not controlling insect pests and diseases was the high cost of chemicals and ignorance [3], [4]. Many farmers admitted they did not know the difference between disease and insect pests attack symptoms. Thus wrong control measures could have been used for control of either disease or insect pests. These results are similar to findings from other studies, for instance, [5] reported low yields in common bean (*Phaseolus vulgaris*) as a result of lack of disease control, use of poor quality seed and poor cultural practices such as late weeding by farmers in Ethiopia and Eastern Kenya. According to [6] constraints of navy bean production in Kenya is lack of good quality seed and lack of technical skills.

The study found out that all respondents who grew Lablab utilized it as food. Others used it as a livestock feed and in such places as Mbeere, Mwingi and Maragwa it was used in conservation agriculture where it was commonly grown on bench terraces. Lablab is grown as a pulse crop in Africa, Asia and the Caribbean [7]. The crop is also used as a source of revenue as it fetches high prices than common bean per unit quantity. A market survey conducted in Eastern Africa found out that Lablab has a high demand and subsequently fetches high prices in Kenya [8]. The study shows that in Kenya Lablab is popularly used as dry beans for food while in India and China edible pods are more popular [8].

The level of adoption of new varieties was particularly encouraging as 44.4% of the respondents planted seeds supplied by the Ministry of Agriculture (DL1002, or DL1009) from KARLO, Katumani. However, 20.4% of growers obtained seed from neighbours and market [3], [4]. Similar results in different crop species have been reported by other workers for instance, in Botswana it was found out that while most of the farmers' preferred to use the previous season's harvest as their seed stock, they also exchanged bambra groundnut seeds with friends and family members [9].

A greater percentage of the respondents wanted a technology that reduced the cost of production with regard to pest and disease management. Farmers complained about the high cost of pesticides, reduced efficacy of the chemicals used as well as the time spent spraying given that some varieties are perennial. Besides, regular spraying is not only expensive, but also hazardous to the environment. It was also noted during the survey that there was a problem with identification of pests or diseases as many farmers confused the two hence the chances of misappropriate control strategies [3], [4]. The challenges identified in Lablab production in

Kenya are similar to those reported by other workers for instance, [10] reported that insect pests were a major constraint in production and storage of cowpea seed in Nigeria. He further observed that studies on resistant varieties were conducted where resistance genes from wild cowpea species were successfully transferred into cultivated cowpea varieties including resistance to the storage weevil (*callosobrochus maculate*), leaf hopper and aphids.

Performance of Dolichos Bean under Different Agro-Ecological Environments

A genotype or variety is considered to be more adaptive or stable if it has high mean yield but a low degree of fluctuation in yielding ability when grown over diverse environments [11]. Different accessions were affected differently by production environments. These variations could be attributed to different climatic and edaphic conditions at the different sites. Among the tested Lablab accessions, number 36 (collected from Nakuru-Bahati) had the highest yield in Nakuru and Uasin-Gishu while accession 7 (collected from Lamu) gave the highest yield in Bungoma. Accession 36 also ranked highly in Bungoma. Accessions 23 and 24 collected from Murang'a-Makuyu had also good performance in the three sites. The significantly higher number of pods per plant recorded by accession 36, 23 and 24 across sites could indicate that they were more efficient in partitioning photo-assimilates into pods and consequently into seeds. It also implies that the accessions were not affected negatively by the three environments and could be well adapted to the three locations.

The environmental effects and the interactions between genotype and environment highlight the different response of genotypes to environmental conditions. This means that the best genotype for one environment is not the best for another. Therefore, it is important that specific types of genotypes are developed to overcome the interaction of genotype by environment [12]. This study has also demonstrated that different Lablab genotypes performed differently in different environments where accessions 22, 23 and 36 performed highly in Nakuru and Uasin-Gishu and accession 7 was the best performer in Bungoma.

5. CONCLUSION

The most limiting constraints to dolichos bean production in Kenya include insect pests, diseases, poor seed quality, and lack of technical knowhow by farmers. Performance of dolichos bean accessions is affected by environment in which they are grown. Accessions 22, 23 (from Makuyu) and 36 (from Bahati) proved to have high yield potential and took a relatively shorter period to mature in Njoro and Eldoret while accession 7 (from Lamu) was the best performer in Bungoma. The four accessions could therefore be adopted as suitable genotypes in the respective agro-ecological environments for enhancement of food security in those areas.

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