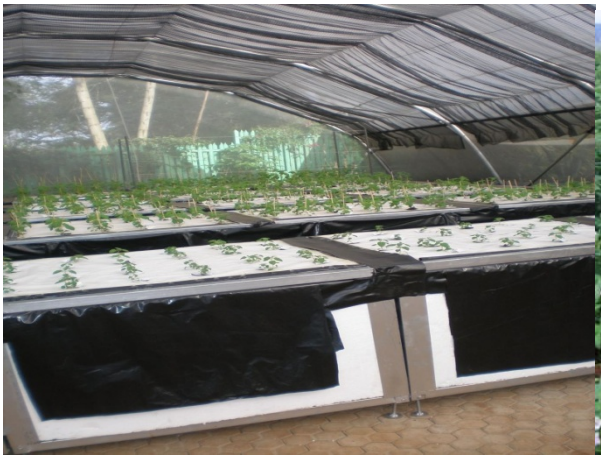
Seed Potato Use and Projected Demand in Kenya




Preliminary report


Wachira Kaguongo, Nancy Ng'ang'a & Juan Landeo,

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Summary

In Kenya, potato is highly positioned as both a food and an income source with average seasonal farm acreage of 0.3 ha. It is planted twice and occasionally three times in some districts with variety acreages and seed type used varying from district to district. In 2008, Kenya produced 1,301,704 tons of potato from 158,386 ha, indicating a national yield of 8.2 tons/ha which is far much lower than the potential yield of 25 tons/ha under rain fed condition.

Farmer seed was the most commonly used type of seed and constituted 96.3% of total seed used countrywide while quality seed which comprises certified seed, clean seed and positively selected seed, constituted only 3.7%. Out of the quality seeds used, 1.1% was certified seed, 1.4% was clean seed while 1.2% was positively selected seed. In term of use only 4.1% of farmers used these quality seeds. There was consequently a gaping opportunity for training farmers in use of certified, clean and positively selected seeds in most districts.

Tigoni acreage was highest over all and was grown by 25.7% of farmers in the country while it had the highest variety acreage in Keiyo Marakwet, Nakuru, Nyandarua and Taita ; Asante is highest in Meru; Thima thuti in Narok and Nyeri; Nyayo in Kiambu; Arka in Mt Elgon and Dutch Robjyn in Bomet. Only a few of these farmer preferred varieties (namely Tigoni, Asante and Dutch Robjyn) were in the formal seed system hence there is an urgent need for collection, cleaning and releasing of farmer favored varieties that are highly esteemed by farmers but which are not available as certified seed such as Thima Thuti, Arka, Nyayo, Meru Mugaruro, Shangi, Purple Tigoni, Kanyoni etc. Variety identification and lineage follow-up should also be conducted in all parts of the country to ensure that one variety does not go by different names or many different varieties do not bear the same name in different regions.

Bacterial wilt was a grim reality for the large majority of farmers (> 65% of farmers) with most of them having little knowledge on how to control the disease. A fair number of farmers in Mt Elgon (63%), Narok (49%) and Keiyo Marakwet (44%) sprayed their crop against bacterial wilt and since bacterial wilt is mainly seed or soil borne this could mean inappropriate use of their scarce resources. Seed renewal as a control measure was mentioned by hardly any of the farmers (<10%) in all the districts.

Training on bacterial wilt (what it is, how it is spread and how to control it) is sorely lacking in most of the districts and this is critical if the disease is going to be put in check so as to improve potato output nationally and also allow processing of quality products without the telltale bacterial wilt ring.

Seed sourcing was a big challenge and only a few farmers said they knew a trusted seed source (31%) while most farmers said they had problem getting quality seed (72%). Additionally, in a number of districts (Nakuru, Nyandarua, Nyeri, Taita, Meru and Kiambu) there were less than 1% of seed multipliers. Limitations faced by farmers in accessing quality seed included unavailability (40%), high cost (37%), lack of knowledge (14%), distance to the seed (12%) and poor roads (%). Solutions offered by farmers to increase access of quality seed included lowering the price of quality seed (25%); increasing number of seed stations (23.5; and providing training (23%).

On average, farmers travelled 142 km to source for certified seed compared to 37 km for clean seed and less than 20 km for positively selected and farmer seeds. This means reducing distance of source of certified seed through improved distribution is critical in improving its access.

Farmers indicated willingness to pay a premium for seed quality which means they recognized the importance of seed quality in improving yields. Proportionately, farmers nationally were willing to pay for certified seeds 1.9 times the price of the farmer seeds; for clean seed 1.7 times the price of farmer seed; and for positively selected seeds 1.4 times the price of farmer seed.

Although seed storage was common (90%) only 4% were trained on the use of improved seed store (DLS). This means that farmers stored their seeds in less than ideal conditions affecting their quality and viability and consequently the yields. Storing in dark stores (25%) or dark houses (9%) lead to seed producing few, long, weak sprouts that either break at planting or give poor germination and resulting to low yields. Storing seeds in the field while covered (12%) leads to poor sprouting as well as high rots. The need for use of DLS at the district level is thus critical and thus training in DLS is paramount.

Less than half of all farmers (48%) had received agriculture training but less than half of these (20%) had been trained in any aspect of potato production with only a minority (7%) having trained in the last twelve months preceding the survey. Most farmers thus produce potatoes using knowledge garnered over the years, from parents or from neighbors' and this production knowledge may or may not be optimal depending on the source. Proper potato production information therefore should be disseminated so as to take potato production to a higher level.

This study indicates there are diverse opportunities in different aspects of the seed value chain touching on various aspects of production, storage, marketing and distribution.

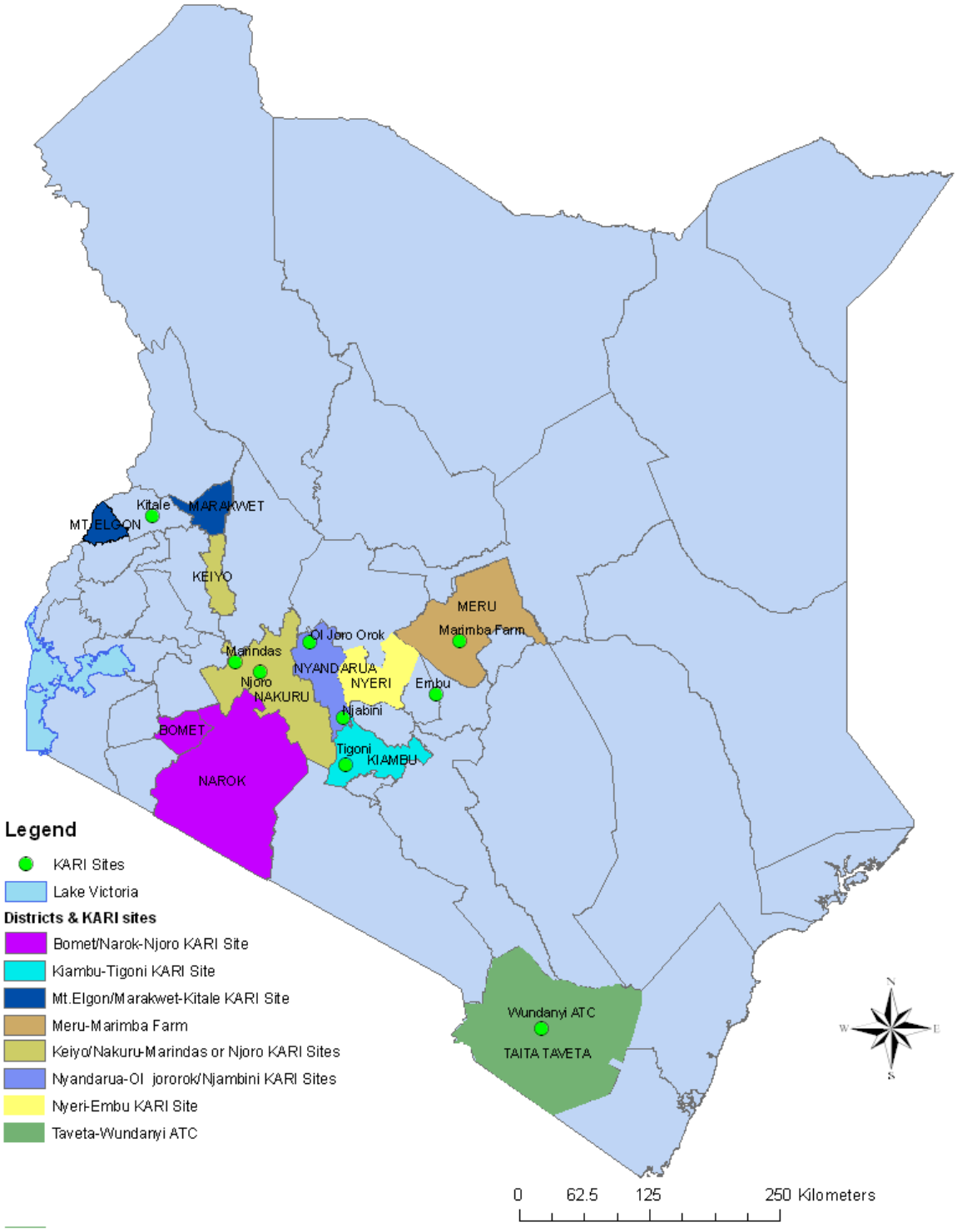
Background

In Kenya, potato ranks as the second most important food crop after maize (Guyton et al., 1994, Seed potato study 2009). Potato is both a staple food and a cash crop in many rural and urban families in Kenya and plays an important role in national food and nutrition security, poverty alleviation, and income generation and provides employment in production to consumption continuum (Kabira *et al*, 2007). There is increasing trade to supply the growing cities and towns with cheap food stable food and satisfy the growing fast food industry. About 60-65% of the fresh potato supplied by urban traders in Kenya is processed in fast food outlets such as restaurants and street stalls (ECAPAPS, *et al*., 2005; Kirumba *et al*, 2004).

Potato production in Kenya occurs mainly in the highlands of central, eastern and rift valley districts, in Mau range and the slopes of Mt. Kenya. Moreover, other regions such as Mt. Elgon in the Western province and Taita Taveta in the southern border region with Tanzania have also started growing potatoes on commercial basis, see Figure 1.

Potatoes were introduced in British colonial times in Kenya and other parts of East Africa in the 1880s. After 1920s, the crop become popular with indigenous Kenyan farmers also starting potato cultivation, especially in the former white highlands where the yields obtained were 22.5t/ha and eventually entering export market in 1923. However, during the 1930s Kenyan potato production suffered both from economic problems associated with the global depression and from pests and diseases (Waithaka 1976).

Figure 1: Map of Kenya showing main potato producing districts and proposed NPT sites



The formal system of potato seed production in Kenya started progressively in 1958 and by 1980s the system had achieved technical and organizational efficiency. New potato varieties and seed potato production were introduced at the National Agricultural Laboratories, Kabete in 1903 and at Plant Breeding Station, Njoro in 1927. In 1967 the Kenyan government under the technical assistance from West Germany and the UK started a project on potato development with a mandate of establishing programs in variety screening, plant breeding, seed multiplication, and agronomy (Durr and Lorenzel 1980). During this time, a basic seed production station was established at Tigoni, which is now KARI-Tigoni, and by 1979 it became a full potato research station. The basic elements of the potato development program were; CIP was maintaining and supplying clean foundation seed to KARI-Tigoni, KARI-Tigoni increased the production of basic seed and released varieties like the widely adapted white and red skin potato varieties and provided for seed inspection. Seed multiplication was then carried out by ADC and several large scale farmers. Between 1970s and 1980s the Faculty of Agriculture, University of Nairobi, and the International Potato Centre cooperated with the national potato program in conducting and promoting research and extension activities on potato (Nkanya 1984; Kabira and Njoroge 1982). However, in the 1990s many elements of the potato development system collapsed and ware potato production started to decline; for instance KARI- Tigoni, was not able to release new varieties between 1988 and 1997; this led to the development of an entrenched farmer seed system which has continued to thrive.

Institutional changes and special projects were initiated in the late 1990s to early 2000 in attempts to revive a structured seed potato system in Kenya. The basic elements were: CIP was to continue maintaining and supplying clean foundation seed to KARI-Tigoni, KARI-Tigoni under a special project (Foundation Seed Unit -FSU) – was to increase production of basic seed and release new varieties, KEPHIS would provide voluntary seed inspection, seed multiplication and distribution could then be carried out by NGOs' interested in farmer based seed production. During the same period CIP set up special projects to finance pre-basic seed production and to stimulate farmer-based seed multiplication (Crissman, *et.al*., 1999). Since then only remnants of

this system remain and the operational elements have been inefficient, allowing the farmer seed system to thrive.

Objectives and justification

Potato yields have been declining in the recent past at the rate of 11% per year (Figure 2). This trend has been blamed mainly on adverse weather conditions; poor soil fertility, use of low yielding varieties and poor quality seeds (Kaguongo et al, 2008; Okoboi, 2001). Despite the fact that clean and certified potato seed are viewed as holding the key to improved yields in potato production, very few farmers use these high quality seeds. According to Kaguongo et al (2008) 94% of seed potatoes used by farmers in Kenya in 2005 were sourced from farmers who are not trained on how to produce clean seeds (farm saved seed and neighbor harvests). Clean and positively selected seeds constituted about 2.9% while certified seeds alone hardly exceed 1%. Although limited quantities of clean seeds are available from trained farmers' associations, seed growers and national research stations, there exists, institutional, infrastructural, regulatory, policy and knowledge barriers that have hampered effective utilization of clean and certified potato seed thus reducing the benefit. Similar barriers have also hindered full participation of private sector and other stakeholders in development of potato sector.

Although numerous germplasm of superior qualities exist in other countries and in CIP's gene bank only a few improved varieties have been tested and adopted in Kenya. Furthermore, only a few of the superior varieties have been pre-released due to inability of KARI-Tigoni to produce enough quantities to meet the mandatory seed stock. The limited capacity of KARI, which is the public institution mandated to produce basic seed of old cleaned (disease free) and new varieties for further multiplication, has also lead to only a handful of new varieties and minimal quantities of certified seeds entering the distribution system each season.

In addition, the post-election mayhem in early 2008 lead to the loss of most of the certified and clean seeds in institutions, group and individual farms in Rift valley, which is an important seed producing region, elevating the seed crisis.

The objectives of the study were:

i) to evaluate the awareness status on the need for clean and certified seeds amongst farmers

ii) to estimate the demand and supply of clean and certified seed potato and the willingness to pay by farmers

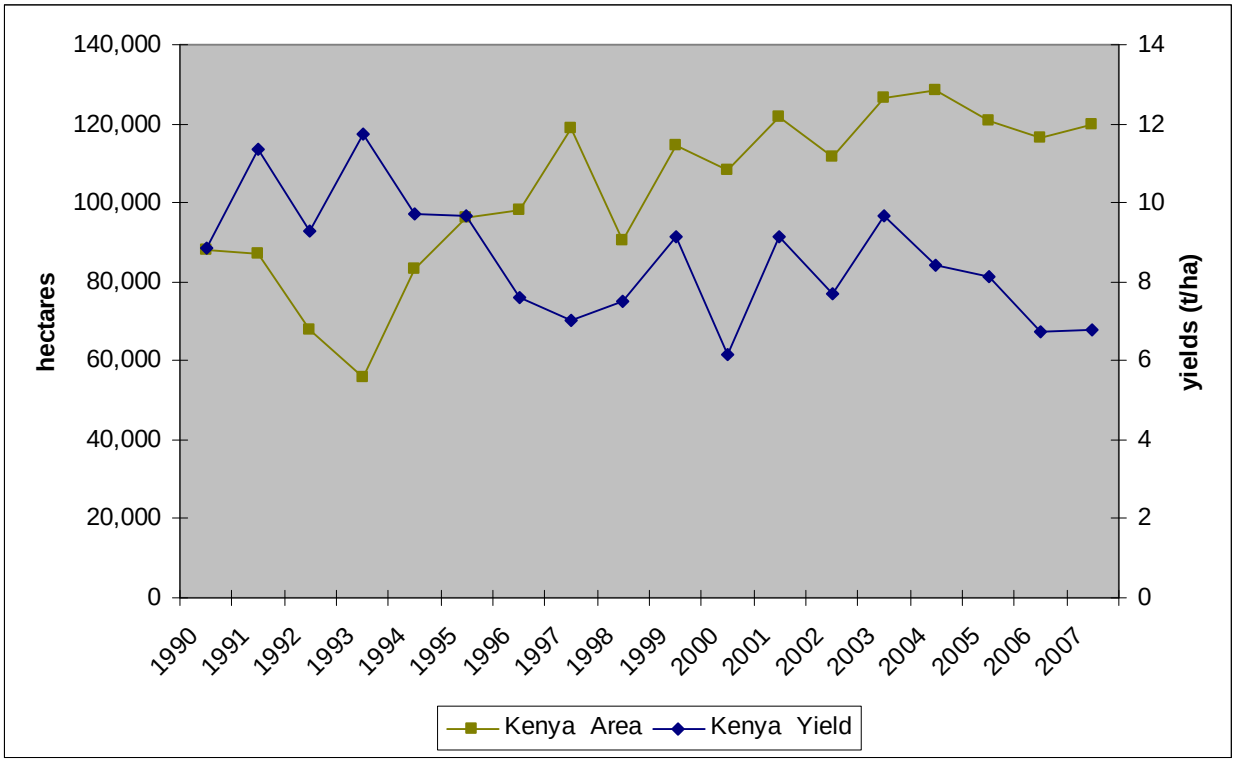


Figure 2: Potato production area and yields (1990-2007)

Study Areas

The study was conducted in the 10 main potato growing (old) districts in Kenya, namely Kiambu, Nyeri, Meru, Nyandarua, Nakuru, Bomet, Narok, Mount Elgon, Taita- Taveta, and Keiyo -Marakwet.

Figure 1 above shows the map of Kenya with main potato growing districts[1] visited

Data collection

This involved collecting household data from farmers to help estimate quantitatively the demand and supply of certified and clean seeds and take audit of constraints facing farmers in accessing good quality seeds. A sample size of 1300 randomly selected farmers from 10 major potato producing districts was targeted. A questionnaire with both closed and open questions was used to interview randomly selected farmers. The information collected included awareness of the need to use clean seed, accessibility and availability of clean and certified seeds, source and prices of different seed types used. Sampling was done at several levels: all potato producing divisions in the 10 district were selected, half of the locations in the divisions were randomly selected and half of sub-locations in the locations were randomly selected. One village was randomly selected from each sub-location and five farmers were selected from each village to account for 0.7% of the households in each district (**Table 1**).

Table 1: Sampling details per district

District	**Divisions**		**Locations**		**Sub-locations**		**Villages**		**Household**
	Potato producing	Selected	Total producing	Selected	Total producing	Selected	Total	Selected	Selected hhds
1. Meru (Imenti north & Central)	5	5	25	22	67	29	118	29	145
2. Keiyo-Markwet (Keiyo & Marakwet)	5	5	18	10	37	20		16	80
3. Mt. Elgon	4	4	12	6	25	15		11	56
4. Nakuru (Nakuru & Molo)	11	11	45	45	90	35		40	202
5. Narok (North & South)	5	4	19	9	34	20		18	88
6. Bomet	2	1	8	8	23	10	95	10	48
7. Nyandarua (North & South)	6	6	26	26	79	24		35	175
8. Nyeri (South & North	7	7	25	13	135	58	270	52	260
9. Taita	4	4	12	6	27	13	108	12	62

[1] Larger or older districts which existed before creation of new districts between 2007-2009

10. Kiambu (East & West)	8	8	34	18	52	26	131	44	221
Total								267	1337

Study findings

Farmer characteristics

Overall, farmers owned an average of 1.7 ha and cultivate an average of 1.3 ha with differences witnessed across districts with the highest farm and cultivated areas in Narok and the lowest in Kiambu. The farmers had a varied amount of experience (14 years) in potato production with the most experienced farmers being in Meru (19 years) and the least experience located in Nakuru, Bomet and Taita (8 years)

In the districts visited, potato was the most important income crop (ranked 1st by 46% of farmers) followed by maize (ranked 1st by 12%) whilst together with maize it was the most important food crop (both ranked 1st by 47 % of farmers). Potato was the most important income crop for nearly all Narok (91%) farmers and for more than half of the farmers in Keiyo Marakwet (69%), Mt Elgon (57%), Nakuru (59%), Bomet (58%) and Nyandarua (57%). It was the most important food crop for the vast majority of farmers in Narok (83%) and Meru (73%). Noticeable in Kiambu was the small number of farmers (6%) placing priority on potato as an income earner (table 2).

A little less than half (48%) of potato households in the potato districts experienced month(s) of the year when food was in short supply with differences evident across districts. Nearly all (95%) of Mt Elgon farmers experienced periods of food shortage during the year while relatively fewer (< 40%) of farmers in Meru, Narok, Bomet and Kiambu experienced food shortage episodes during the year (table 2).

Table 2: Farmer characteristics in the major potato districts

	Meru	Keiyo_	Mt Elgon	Nakuru	Narok	Bomet	Nyandarua	Nyeri	Taita	Kiambu	Overall
Gender of household head											
Male	83.8	96.4	91.3	79.8	96.6	96.6	81.8	56.6	67.9	79.0	78.1
Female	16.2	3.6	8.7	20.2	3.4	4.0	18.2	43.4	32.1	21.0	21.9
Average family size (std)	4.9 (2.3)	7.1 (2.8)	9.0 (3.9)	5.9 (2.4)	7.0 (3.4)	6.4 (2.8)	5.7 (2.5)	5.1 (2.6)	5.0 (2.0)	4.8 (1.9)	5.7 (2.7)
Average farm size (ha)	1.2	2.7	2	2	5.2	1.8	1.7	1	1.2	0.8	1.7

Average cultivated farm size (ha)	1.4	3	1.8	1.3	2.8	1.2	1	1.2	1	0.5	1.3
Farmers lacking food at least one month in a year (%)	37	71	95	58	38	33	50	42	58	36	48
% ranking potato as most important income crop (rank)*	68 (1)	69 (1)	57 (1)	59 (1)	91 (1)	58 (1)	57 (1)	24 (2)	48 (1)	6 (4)	46 (1)
% ranking potato as most important food crop (rank)*	73 (1)	36 (2)	27 (2)	32 (2)	83 (1)	48 (2)	43 (2)	47 (2)	21 (2)	45 (1)	47 (2)
% ranking maize as most important income crop (rank)*	3 (5)	17 (2)	18 (2)	24 (2)	2.2 (3)	0(0)	2.2 (4)	7 (4)	3 (2)	10 (2)	47 (2)
% ranking maize as most important food crop (rank)*	15 (2)	57 (1)	66 (1)	63 (1)	15 (2)	47 (1)	49 (1)	51 (1)	73 (1)	43 (2)	12
Experience of growing potatoes (years)	19	10	9	8	10	8	17	17	8	15	14
% that sell more than they consume	63.4	95.0	75.0	80.7	96.6	93.8	74.3	43.1	62.9	22.2	62.3
Sample size	**145**	**80**	**56**	**202**	**88**	**48**	**175**	**259**	**62**	**220**	**1330**

Source: Potato seed Master plan field survey results (2009)

Production

Average farm acreage under potatoes was roughly 0.3 ha in both Mar/May and Sept/Dec in the 10 highest producing districts with variations across districts. The highest potato farm acreage was in Narok (1.2ha) and the lowest in Taita and Kiambu (0.1 ha).

Most farmers (84%) in the potato districts grew potatoes twice a year with differences across districts. Narok had the lowest proportion of farmers (61%) growing potatoes twice a year while 36% of farmers in the same district were growing potatoes three times a year{table 3}.

Table 3: Potato production practices in various districts

District	Meru	Keiyo Marakwet	Mt Elgon	Nakuru	Narok	Bomet	Nyandarua	Nyeri	Taita	Kiambu	Overall (combined districts)
Average farm acreage under potatoes (Ha) {March/May}	0.3	0.5	0.3	0.3	1.2	0.3	0.3	0.2	0.1	0.1	0.3
Average farm acreage under potatoes (Ha) {Sept/Dec}	0.3	0.5	0.2	0.3	1.2	0.3	0.3	0.2	0.1	0.1	0.3
% of farmers growing potatoes twice a year	74	81	84	85	61	77	76	94	82	93	84
% of farmers growing potatoes three times a year	11	11	11	5	36	15	14	3	3	1	9
Sample size	**145**	**80**	**56**	**202**	**88**	**48**	**175**	**260**	**62**	**220**	**1330**

Source: Seed potato master plan field survey results (2009)

Varieties grown

The most commonly grown varieties in the country was Tigoni (cultivated by 25.7% of potato farmers), Nyayo (24.8%), and Thima thuti (22.7%). The highest acreages in 2008 were under Tigoni , grown in 20.7% of potato areas (23,618ha) and Thima thuti, grown in 20.2% of potato areas (23,047ha) as farmers growing Nyayo planted it on smaller farm acreages than either Tigoni and Thima thuti (Table 4). Widely grown varieties do not always have the highest acreage as overall Dutch Robjyn acreage (11,980ha) was higher than that of Nyayo (10,839 ha) even though only 8.9% of all farmers grew Dutch Robjyn compared to 24.8% growing Nyayo (Table 5).

Tigoni holds sway in Nakuru (grown by 64% of potato farmers), Taita (55% farmers), Keiyo Marakwet (82.5% farmers) and had some presence in Nyandarua (34%). The highest Tigoni acreage was in Nakuru (7,540 ha) followed by Keiyo Marakwet (6,578 ha) and Nyandarua (2,980 ha). Despite more than half (55%) of Taita farmers growing Tigoni the total acreage under Tigoni was 710 ha.

Nyayo was common with farmers in Nyandarua (41.1%) and Kiambu (47.5%), Nakuru (37.1%) and Nyeri (26.5%) with the highest acreage in Nakuru (2,845ha) and Nyandarua (2,604ha). Even

though 47.5% of Kiambu farmers grew Nyayo their total acreage is lower than that of Nakuru and Nyandarua farmers.

Thima thuti reigned in Narok (72.7%) and Nyeri (64.6%) with some presence in Kiambu (29.9%). The highest acreage of Thima thuti was in Narok (17,606ha) followed at a distant second by Nyeri (5,148ha)

Although Dutch Robjyn was grown in Narok (23.9%) and Taitta (32.3%) it was of singular importance in Bomet (81.3%). However the highest Dutch acreage was surprisingly in Narok (4,242ha) followed by Bomet (3,685ha) and Nakuru (3,124ha).

Districts with unique but widespread varieties (over 2,000ha) were Mt Elgon with Arka (91.1% of farmers) and an acreage of 2,973 ha, Meru with Purple Tigoni (38.6% of farmers) and acreage of 2,742ha and Asante (31.7%) and 3,942ha; and Nyandarua with Shangi (26.7%) and acreage of 2,047ha.

Table 4: Commonly grown varieties in the various districts (% of farmers growing)

Variety	Meru	Marakwet	Mt Elgon	Nakuru	Narok	Bomet	a	Nyeri	Taita	Kiambu	Total
Tigoni	15.9	76.3	1.8	61.9	3.4	.0	29.7	7.7	48.4	13.1	25.7
Nyayo	.0	6.3	3.6	37.1	2.3	.0	41.1	26.5	3.2	47.5	24.8
Thima thuti	.0	.0	.0	1.0	72.7	.0	2.3	64.6	.0	29.9	22.7
Dutch Robjin	.0	.0	.0	19.3	23.9	81.3	.0	.0	32.3	.0	8.9
Asante	31.7	1.3	12.5	14.4	.0	.0	.0	1.9	19.4	1.4	7.7
Shangi	.0	.0	.0	.0	5.7	.0	25.7	.0	.0	16.7	6.5
Meru Mugaruro	.0	.0	1.8	2.5	.0	.0	13.7	12.3	.0	10.4	6.4
Arka	6.9	8.8	91.1	.0	.0	.0	.0	.0	.0	.9	5.2

Meru	.0	.0	1.8	2.5	.0	.0	1.7	15.8	.0	5.9	4.7
Purple Tigoni	38.6	.0	.0	.0	.0	.0	1.7	.8	1.6	.0	4.6
Tigoni red	4.8	.0	.0	.0	.0	.0	1.7	9.6	12.9	6.3	4.3
Desiree	3.4	.0	7.1	2.5	.0	20.8	2.3	1.2	1.6	1.4	2.6
Mwezi moja	.0	.0	.0	.5	.0	.0	.6	10.4	.0	.0	2.2
Kanyoni	.0	.0	.0	.0	.0	.0	.6	10.8	.0	.0	2.2
Anett	.0	12.5	.0	.0	.0	.0	.0	.0	.0	.0	.7
Sample size	**145**	**80**	**56**	**202**	**88**	**48**	**175**	**260**	**62**	**221**	**1337**

Source: Master plan field survey results (2009)

Table5: Percentage area under different varieties in 2008

	Meru	Keiyo_ Marakwet	Mt Elgon	Nakuru	Narok	Bomet	Nyandarua	Nyeri	Taita	Kiambu	Total
Tigoni	12.3	73.6	8.4	43.2	3.5	0.0	21.4	9.2	37.1	9.5	20.7
Thima Thuti	0.0	0.0	0.0	0.3	61.4	0.0	1.9	34.8	0.0	19.2	20.2
Dutch Robyjin	0.0	1.2	2.0	17.9	14.8	86.8	0.1	0.0	24.6	0.0	10.5
Nyayo	0.9	0.8	0.3	16.3	3.5	0.0	18.7	14.1	1.1	26.1	9.5
Asante	33.5	0.7	12.4	6.9	0.7	0.0	2.0	1.8	15.9	1.1	6.5
Shangi	0.0	0.0	0.0	0.0	5.6	0.0	14.7	0.0	0.0	9.4	3.7
Meru mugaruro	0.0	0.0	1.0	0.9	1.2	0.0	13.0	5.5	0.0	13.8	3.6
Arka	3.3	6.1	66.5	0.0	0.0	0.0	0.0	0.0	0.0	1.2	3.5
Purple	23.3	0.0	1.2	0.0	0.0	0.0	1.7	1.7	0.2	0.0	3.1

Tigoni											
Meru	8.0	0.0	1.0	2.3	0.0	0.0	1.4	5.4	0.0	2.7	2.3
Tigoni red	1.9	0.8	0.0	0.0	0.0	0.0	0.9	7.8	3.2	5.0	1.7
Desiree	0.8	0.0	4.6	1.8	0.0	9.8	1.9	0.1	0.1	2.1	1.3
Kanyoni	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5	0.0	0.0	0.9
Annett	0.0	9.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
Tana Kimande	0.0	0.0	0.0	0.2	0.0	0.0	4.0	1.5	0.0	1.3	0.8
Ngure	5.4	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.6
Other varieties	10.5	7.1	2.6	10.2	9.2	3.4	18.1	10.6	17.7	8.7	10.2
Sample size	**145**	**80**	**56**	**202**	**88**	**48**	**175**	**260**	**62**	**221**	**1337**

Source: Master plan field survey results (2009)

Total Area (ha) under various varieties in 2008

Old District	Meru	Keiyo-Marakwet	Mt Elgon	Nakuru	Narok	Bomet	Nyandarua	Nyeri	Taita	Kiambu	Total
Potato area	11,768	8,938	4,470	17,455	28,664	4,246	13,927	14,794	1,914	7,921	114,096
Tigoni	1,447	6,578	375	7,540	1,003	0	2,980	1,361	710	753	23,618
Thima Thuti	0	0	0	52	17,600	0	265	5,148	0	1,521	23,047
Dutch Robyjin	0	107	89	3,124	4,242	3,685	14	0	471	0	11,980
Nyayo	106	72	13	2,845	1,003	0	2,604	2,086	21	2,067	10,839
Asante	3,942	63	554	1,204	201	0	279	266	304	87	7,416
Shangi	0	0	0	0	1,605	0	2,047	0	0	745	4,222
Meru mugaruro	0	0	45	157	344	0	1,811	814	0	1,093	4,107

Arka	388	545	2,973	0	0	0	0	0	0	95	3,993
Purple Tigoni	2,742	0	54	0	0	0	237	251	4	0	3,537
Meru	941	0	45	401	0	0	195	799	0	214	2,624
Tigoni red	224	72	0	0	0	0	125	1,154	61	396	1,940
Desiree	94	0	206	314	0	416	265	15	2	166	1,483
Kanyoni	0	0	0	0	0	0	0	1,110	0	0	1,027
Annett	0	867	0	0	0	0	0	0	0	0	913
Tana Kimande	0	0	0	35	0	0	557	222	0	103	913
Ngure	635	0	0	0	0	0	28	0	0	0	685
Other varieties	1,236	635	116	1,780	2,637	144	2,521	1,568	339	689	11,638
Sample size	**145**	**80**	**56**	**202**	**88**	**48**	**175**	**260**	**62**	**221**	**1337**

Source: Master plan field survey results (2009)

Seed types grown

Most of the seed used countrywide by farmers was ordinary or farmer seed, constituting 95.5% of total area planted, while area of quality seed (certified seed, clean seed and positively selected seed) constituted 4.5%. Out of the quality seeds area, 1.2% was certified seed, 1.5 was clean seed while 1.8% was positively selected seed. In term of use only 7.9% of farmers used these quality seed with 1.3% using certified, 1.9% using clean seed and 3.4% using positively selected seed

(Table 7: Area under different type of seeds; percentage use by weight and of farmers using in 2008

	Meru	Marakwet	Mt.Elgon	Nakuru	Narok	Bomet	Nyandarua	Nyeri	Taita	Kiambu	All district s	National**
Percentage area under different type of seeds												

Certified	0.7	1.6	0.0	1.7	2.3	0.0	1.6	0.0	4.3	1.4	1.4	1.2
Clean	6.0	0.3	0.0	1.1	1.1	14.2	0.4	0.0	5.6	1.4	1.9	1.5
Positive	7.4	0.0	0.0	0.0	0.6	0.0	1.2	4.9	7.3	0.0	1.8	1.5
Unselected	85.9	98.1	100.0	97.2	96.0	85.8	96.9	95.0	82.7	97.2	94.9	95.8
Percentage by weight of seed type used												
Certified	0.7	0.0	0.0	1.7	2.3	0.0	1.6	0.0	0.0	1.4	1.3	1.1
Clean	6.0	0.3	0.0	1.1	1.1	14.2	0.4	0.0	5.9	0.0	1.8	1.4
Positive	7.4	0.0	0.0	0.0	0.6	0.0	1.2	4.9	7.7	0.0	1.5	1.2
Unselected	85.9	99.7	100.0	97.2	96.0	85.8	96.9	95.0	86.4	98.6	95.4	96.2
Percentage **of farmers growing**												
Certified	0.7	3.8	0.0	2.0	1.1	0.0	1.1	0.0	1.6	0.9	1.0	0.9
Clean	3.4	1.3	0.0	1.0	1.1	8.3	1.1	0.4	0.0	0.9	1.3	1.0
Positively Selected	11.7	0.0	0.0	0.0	1.1	0.0	1.1	5.4	4.8	0.0	2.8	2.2
Quality	15.2	5.0	0.0	3.0	3.4	8.3	3.4	5.8	6.5	1.8	5.1	4.1
Farmer	90.3	97.5	100.0	97.5	96.6	91.7	97.7	95.8	96.8	98.6	94.9	96.9

*Zero means use of the type of seed was not noticeable in the district

** National figures obtained through extrapolation

Source: Master plan field survey results (2009)

The highest certified seed use was in Keiyo Marakwet (3.7% of farmers) and in Nakuru (1.7%) and this can be attributed to the presence of ADC in the Nakuru area and the activities of farmer groups growing certified seed in Keiyo Marakwet. Use of certified seed was not noticeable in Mt Elgon and surprisingly also in Nyeri.

Use of clean seed was mainly found in Bomet (7.8% of farmers) and Taita (8.1% of farmers) while there was no noticeable use of clean seed in Mt Elgon.

The highest use of positively selected seed was in Meru (13.5% of farmers) and Nyeri (11.9%) while it was not noticeable in Mt. Elgon, Keiyo Marakwet, Nakuru, Bomet and Kiambu

Table 7: Area under different type of seeds; percentage use by weight and of farmers using in 2008

	Meru	Marakwet	Mt.Elgon	Nakuru	Narok	Bomet	Nyandarua	Nyeri	Taita	Kiambu	All district s	National**
Percentage area under different type of seeds												
Certified	0.7	1.6	0.0	1.7	2.3	0.0	1.6	0.0	4.3	1.4	1.4	1.2
Clean	6.0	0.3	0.0	1.1	1.1	14.2	0.4	0.0	5.6	1.4	1.9	1.5
Positive	7.4	0.0	0.0	0.0	0.6	0.0	1.2	4.9	7.3	0.0	1.8	1.5
Unselected	85.9	98.1	100.0	97.2	96.0	85.8	96.9	95.0	82.7	97.2	94.9	95.8
Percentage by weight of seed type used												
Certified	0.7	0.0	0.0	1.7	2.3	0.0	1.6	0.0	0.0	1.4	1.3	1.1
Clean	6.0	0.3	0.0	1.1	1.1	14.2	0.4	0.0	5.9	0.0	1.8	1.4
Positive	7.4	0.0	0.0	0.0	0.6	0.0	1.2	4.9	7.7	0.0	1.5	1.2
Unselected	85.9	99.7	100.0	97.2	96.0	85.8	96.9	95.0	86.4	98.6	95.4	96.2
Percentage of farmers growing												
Certified	0.7	3.8	0.0	2.0	1.1	0.0	1.1	0.0	1.6	0.9	1.0	0.9
Clean	3.4	1.3	0.0	1.0	1.1	8.3	1.1	0.4	0.0	0.9	1.3	1.0
Positively Selected	11.7	0.0	0.0	0.0	1.1	0.0	1.1	5.4	4.8	0.0	2.8	2.2
Quality	15.2	5.0	0.0	3.0	3.4	8.3	3.4	5.8	6.5	1.8	5.1	4.1
Farmer	90.3	97.5	100.0	97.5	96.6	91.7	97.7	95.8	96.8	98.6	94.9	96.9

*Zero means use of the type of seed was not noticeable in the district

** National figures obtained through extrapolation

Source: Master plan field survey results (2009)

Certified seed area was highest in Narok (578 ha) followed by Nakuru (549 ha) and Nyandarua (419 ha) although the highest certified seed output was in Narok (15,000tons) followed by Nakuru (7,679tons). Clean seed acreage was highest in Bomet (1,012 ha) with the highest output in Bomet (10,575tons) followed by Meru (6,582tons). Positive seed acreage was highest in Meru (896.5ha) and Nyeri (769a) with the highest output in Meru (11,295 tons) and Nyeri (5,168.9tons). Farmer seed acreage was highest in Narok (27,478 ha) as well as output (307,811 tons) (Table 8).

Table 6: Acreage, output and yields of different seed types

Old District	Meru	Keiyo-Marakwet	Mt Elgon	Nakuru	Narok	Bomet	Nyandarua	Nyeri	Taita	Kiambu	Total
Certified Seeds											
Total area (ha)	44	94.3	0	549.5	578.4	0	419.3	0	115.7	86.8	1887.8
Yields (t/ha)	17.7	4.8	0	14	25.9	0	13	0	5.9	19.8	
Output (tons)	776.3	451.3	0	7679.2	15000	0	5468.6	0	685.7	1714.3	24052.2
Clean Seeds											
Total area (ha)	506.1	57.8	0	115.7	144.6	1012.1	43.4	5.8	347	57.8	2290.3
Yields (t/ha)	13	9.8	0	10.9	17.3	10.4	8.4	12.6	8.6	13.8	11.3
Output (tons)	6582	565.7	0	1257.1	2500	10575	363.9	72.6	2994	798.1	25846.9
Positively Selected Seed											
Total area (ha)	896.5	0	0	0	462.7	0	115.7	769.2	101.8	0	2345.9
Yields (t/ha)	12.6	0	0	0	5.2	0	16.3	6.7	4.7	0	9.6
Output (tons)	11295.1	0	0	0	2400	0	1885.7	5168.9	480.9	0	22442.9
Farmers Seed											
Total area (ha)	10321	8785.4	4470.2	16789.5	27478.3	3233.7	13348.8	14019.1	1349.3	7776.7	107572
Yields (t/ha)	7.8	10.1	11.5	7.9	11.2	10.7	7.2	4.7	3.2	3.6	6.9
Output (tons)	81011.1	88790.6	51318.5	133381.4	307811.5	34633.2	95873.4	66406	4346.3	27750.1	741598

Source: Master plan field survey results (2009

Seed and ware prices

On average, seed prices were higher than ware prices which means' the market distinguishes between the two. Exceptions were in Nyeri where farmer seed and ware seed prices are the same and in Nyeri and Taita where farmer seed was cheaper than ware potatoes. Seed prices also varied with perceived quality and certified seed had the highest price followed by clean seed except in Keiyo Marakwet, Nyandarua and Taita(Table 9). The highest ware potato pricewas in Taita (ksh 28/kg) and the lowest in Keiyo Marakwet (ksh10.6/kg) whilst the highest certified seed prices were in Taita and Narok (Ksh40/kg) and the lowest in Nyandarua (ksh11.8/kg); the highest clean seed price was in Taita (ksh41.4/kg) and the lowest in Narok (ksh11.4/kg); positive seed price was highest in Nyandarua(Ksh33.3/kg) and the lowest in Nyeri (ksh14.7/kg); farmer seed fetched the highest price in Taita(ksh25.9/kg) and the lowest in Keiyo Marakwet and Nakuru (ksh11.9/kg). High seed prices in Taita were attributed to the geographic isolation of the area from other potato growing areas so that at planting time the scarce seed is in high demand trading at high prices.

Table 7: Prices of ware and seeds

Old district	Meru	Keiyo-Marakwet	Mt Elgon	Nakuru	Narok	Bomet	Nyandarua	Nyeri	Taita	Kiambu	Total
	Mean (n)	Mean (n)	Mean (n)	Mean (n)	Mean (n)	Mean (n)	Mean (n)	Mean (n)	Mean (n)	Mean (n)	Mean (n)
Average ware price (ksh/kg)	18.5 (139)	10.60 (67.00)	10.80 (50.00)	11.9 (170)	10.80 (79.00)	11.4 (42)	11.2 (140)	15.30 (249.00)	28 (52)	16.5 (173)	14.50 (1161.00)
Average certified seed price (ksh/kg)	30.00 (1.00)	38.30 (3.00)	0.00	20.50 (4.00)	40.00 (1.00)	0.00	11.8 (2)	0.00	40.00 (1.00)	38.5 (2)	29.1 (14)
Average clean seed price (ksh/kg)	30.90 (7.00)	39.00 (1.00)	0.00	13.60 (1.00)	11.4 (1)	20.9 (4)	38.00 (1.00)	15.00 (1.00)	41.4 (4)	15.00 (2.00)	27.9 (22)
Average positive seed price (ksh/kg)	22.00 (19.00)	0.00	0.00	0.00	0.00	0.00	33.3 (1)	14.7 (31)	27.5 (4)	0.00	18.5 (55)
Average farmer seed price (ksh/kg)	19.80 (111.00)	11.9 (71)	12.4 (54)	11.9 (178)	12.4 (79)	13.6 (42)	12.6 (137)	14.1 (215)	25.9 (37)	16.7 (206)	14.6 (1130)

Source: Master plan field survey results (2009

Input use

Nearly all farmers (95%) used either organic (manures) or chemical fertilizers. Most farmers (80%) in the major potato producing districts had used chemical fertilizers during their latest potato growing before (before the interview) while a slight majority (64%) had used manures. There were differences across districts in the use of both chemical and organic fertilizer. Bomet farmers did not use manure at all but they all used fertilizers. Similarly, organic fertilizer was used by a small proportion of farmers (<10%) in Keiyo Marakwet and Mt. Elgon but was widely used by farmers in Nyeri Taita and Kiambu (>90% in each district). Use of chemical fertilizer was lowest in Kiambu (54%) and highest in Bomet district (100%) (Table 10)

Intercropping was carried out by a few (27%) of all farmers with differences from district to district. Most farmers in Nyeri (61.5%) and Meru(51%) intercropped their potatoes with mainly maize. Only a sprinkling of farmers in Nakuru (8%), Narok (6%) and Bomet (2%) intercropped their potatoes.

Table 8: Fertilizer use and intercropping by district

District	Meru	Keiyo Marakwet	Mt Elgon	Nakuru	Narok	Bomet	Nyandarua	Nyeri	Taita	Kiambu	Overall (major districts
% of farmers using chemical fertilizer in their last production season	92	92	69	94	89	100	77	79	65	54	
% of farmers using organic fertilizer in their last production season	83	8.5	7	24	37	0	74	94	90	97	
% of farmers intercropping potato	51	21	34	8	6	2	24	62	13	10	27

Crop used most in intercropping (% farmers using crop)	Maize (44)	Maize (11)	Beans (21)	Maize (5), Beans (5)		Beans (2)	Maize (10), Beans (10)	Maize (48)	Maize (13)	Maize (8)	Maize (

Source: Master plan field survey results (2009

Diseases and Pests

Over ally Bacterial wilt was the most prevalent disease reported by 77% of potato farmers followed by Late blight (67%) and viruses (12%) although there were apparent differences across districts. Leaf roll was the most reported virus disease. Viruses' were widely reported only in Mt. Elgon (71.5%) while late blight was reported by the least number of farmers in Kiambu (23%) and by the highest number of farmers in Narok (91%) and Keiyo Marakwet (89.5%)(Table 11). Bacterial wilt was reported by most farmers in Nyeri (90%), Bomet (87%) and Nyandarua (83%)

In the last 5 years preceding the survey some of the farmers (20%) had experienced total crop failure as a result of drought (9%), bacterial diseases (4%), flooding (2%), late blight diseases (2%), lack of fertilizers (2%) and post election violence (1%). Total crop failure was experienced most by farmers in Taita (35.5%) and least by those in Kiambu (12%) and Nyandarua (13%)(table 10).

Table 9: Commonly reported diseases in the major potato producing districts

District	Meru	Keiyo Marakwet	Mt Elgon	Nakuru	Narok	Bomet	Nyandarua	Nyeri	Taita	Kiambu	Overall (combined
% of farmers to whom Leaf Roll is a common problem	30	12	71	7	9	2	10	2	16	2	
% of farmers to whom Bacterial wilt is a common problem	76	74	76	73	71	87	83	90	73	67	
% of farmers to whom Late blight is a common problem	70	89.5	60	86	91	84	61	72	79	23	
% of farmers to whom viruses are a common problem	31	12	71	7	10.5	2	11	2	16	2	

% of farmers experiencing total crop failure in last 5 years	23	24	25	26	19	21	13	21.5	35.5	12	

Source: Master plan field survey results (2009

Late Blight tolerance

Varieties believed to be tolerant to late blight varied across districts with the highest number of farmers believing Tigoni to be tolerant especially in Keiyo Marakwet (38%) and Nakuru (27%). Other varieties believed to be tolerant by many farmers are Arka (27%) in Mt Elgon and Dutch Robjyn (20%) in Bomet (Table 12).

A few farmers (34%) believed they knew how late blight is spread. The most cited method for spreading late blight was infected seed (13.5%), weather (10%) and infected soil (10%) with infected seed most commonly mentioned in Taita (37%), Keiyo Marakwet (31%), Nakuru(27%) and Mt Elgon (20%). Weather is named in Nakuru(21%), Keiyo Marakwet (16%), Nyandarua(14%) and Nyeri(21%) while infected soil is quoted in Taita(32%), Keiyo Marakwet (26%), Nakuru(17%), Mt Elgon (14%) and Bomet(12.5%). Another method referred to is flooding in Keiyo Marakwet(17.5%) and Nakuru(14%).

Late blight control was mainly through chemical spraying (55%) with its use being most prevalent in Narok (89%), Keiyo Marakwet (84%), Nakuru (75%) and Bomet (71%).

Table 10: Tolerance and control of Late blight

District	Meru	Keiyo Marakwet	Mt Elgon	Nakuru	Narok	Bomet	Nyandarua	Nyeri	Taita	Kiambu	Overall (combined districts)
Varieties considered tolerant (% of farmers considering variety LB tolerant)	Asante (13), Tigoni(11)	Tigoni (38), Nyayo (12), Arka (10)	Arka (27), Asante (11)	Tigoni (27), Asante (10)	Thimathuti(10)	Dutch Robjyn(20)	-		Tigoni (13)	-	-

Methods of spreading LB (% of farmers citing method)	-	Infected seed (31), infected soil (26), flooding (17.5), weather (16)	Infected seed (20), infected soil (14)	Infected seed (27), weather (21), infected soil (17), flooding (14)	-	Infected seed (12.5), infected soil (12.5)	Infected seed (14), weather (14)	Weather (12), Infected seed (11)	Infected seed (37), infected soil (32)	-	Infected seed (13.5), weather (10), infected soil (10)
Control methods used for LB (% farmers citing method)	Spraying (60)	Spraying (84), uprooting (31), crop rotation (26)	Spraying (54), crop rotation (27), uprooting (18)	Spraying (75), uprooting (19), crop rotation (15)	Spraying (89), crop rotation (11)	Spraying (71), renew seed (15), crop rotation (12.5)	Spraying (47), uprooting (12)	Spraying (50)	Spraying (66), crop rotation (52), uprooting (31)	Spraying (14%)	Spraying (55), crop rotation (12), uprooting (10)

Source: Master plan field survey results (2009

Bacterial wilt

Varieties labeled as resistant to Bacterial wilt were Tigoni in Keiyo Marakwet (30.5%) and Nakuru (17%), Arka in Mt Elgon(36%), Dutch Robjyn in Bomet(12%) and Asante in Mt Elgon(11%).

More than half (56%) of farmers believed they knew how bacterial wilt is spread. Quite a number of farmers believed bacterial wilt was spread mainly through infected soil (41%) and infected seed (37.5%) with variations in the percentage of farmers citing each method from district to district. Infected seed was most cited in Nyeri (62%) and least in Narok (10%) whilst infected soil was most cited most in Nyandarua(51%) and least in Keiyo Marakwet(22.5%).

In the control of bacterial wilt, uprooting (41%), crop rotation (36%) and chemical spraying (21%) were the main control methods. Spraying was the predominant control method in Mt Elgon (63%), Narok (49%) and Keiyo Marakwet (44%) while crop rotation was the lead control

method in Taita (58%), Nyeri(50%), Bomet (46%) and Meru (44%). Uprooting of the crop was the chief method in Nyandarua (62%), Kiambu (47%) and in Nakuru(45%).

Table 11: Tolerance and control of Bacterial wilt

District	Meru	Keiyo Marakwet	Mt Elgon	Nakuru	Narok	Bomet	Nyandarua	Nyeri	Taita	Kiambu	Overall (combined districts)
Varieties often considered tolerant to bacterial wilt (% of farmers considering variety tolerant)	-	Tigoni (30.5)	Arka(36), Asante (11)	Tigoni (17)	-	Dutch Robjyn (12)	-	-	-	-	-
Methods spreading BW(% of farmers citing method)	Infected seed (48), infected soil (43)	Infected seed (30), infected soil (22.5)	Infected soil (36), infected seed (27)	Infected seed (43), infected soil (28)	Infected seed (10)	Infected seed (46), infected soil (46)	Infected seed (55), infected soil (51)	Infected seed (62), infected soil (42)	Infected soil (43.5), infected seed (29)	Infected soil (41), infected seed (24)	Infected soil (41), infected seed (37.5)
Methods used to control BW(% of farmers citing method)	Crop rotation (44)	Spraying (44), uprooting (37.5) , crop rotation (30)	Spraying (63), crop rotation (32), uprooting (30)	Uprooting (45), spraying (29), crop rotation (28)	Spraying (49), uprooting (15), crop rotation (12.5)	Crop rotation (46), spraying (29), uprooting (25)	Uprooting (62), crop rotation (38), renew seed (21), spraying (14)	Crop rotation (50), uprooting (57)	Crop rotation (58), spraying (51), uprooting (34)	Uprooting (47), crop rotation (26)	Uprooting (41), crop rotation (36), spraying chemicals (21)

Source: Master plan field survey results (2009

Seed sources

Untrained farmers were the chief sources of the first variety seed as well as for renewal of seeds. Only in Bomet (69%), Mt Elgon 52%) and Taita did at least half of the farmers renew seed after about 2 to 4 seasons (**Error! Reference source not found.**)

Table 12: Seed sources and renewal rate

	Meru	Keiyo Marakwet	Mt Elgon	Nakuru	Narok	Bomet	Nyandarua	Nyeri	Taita	Kiambu	Overall
Farmers renewing seed (%)	32	42.5	52	40	20.5	69	36	39	50	46	40
Seed renewal rate (after how many seasons)	1.7	2	3.5	2.7	3.6	3	3.5	2	2.3	1.9	2.5
1st seed source (% of farmers using source)	Untrained farmer (62), trained farmers (31), traders (10)	Untrained farmers (76), traders (15)	Untrained farmers (73), traders (16), trained farmers (12.5)	Untrained farmers (84)	Untrained farmers (86)	Untrained farmers (83)	Untrained farmers (75), open market (17), traders (11)	Untrained farmers (56), open market (30), traders (16.5)	Untrained farmers (34), trained farmer (23), open market (16)	Open market (78), untrained farmers (25)	Untrained farmer (62), open market (21)
Last seed source (% of farmers using source)	Untrained farmer (14.5)	Untrained farmers (22.5)	Untrained farme	Untrained farmers	Untrained farmers	Untrained farmers	Untrained farmers (21)	Open market (13),	Own seed (27)	Open market (24),	Untrained farmer (19)

	, trade (10)	, own seed (11)	rs (30)	(31)	(14)	(54)		untr aine d farm ers (11)		untr aine d farm ers (15)	

Source: Master plan field survey results (2009

In total, only a minority of farmers (31%) knew some trusted seed sources with differences at the district level. More than half of Mt Elgon farmers (52%) knew some trusted seed sources while Taita and Nyeri had the least farmers who knew some trusted seed sources. A majority (72%) of farmers had problems getting quality seed with differences at the district level so that a little more than half of Kiambu farmers (56%) had a problem while almost all of the farmers in Taita (98%) had a problem getting quality seed (Table 15).

Table 13: Farmers knowledge of trusted seed sources and access to quality seeds

District	Meru	Keiyo Marakwet	Mt Elgon	Nakuru	Narok	Bomet	Nyandarua	Nyeri	Taita	Kiambu	Overall (combined districts)
% of farmers that knew a trusted seed source	32	40	52	39	31	42	26	21	21	28	31
% of farmers that had problems getting high quality seed	79	74	79	66	67	79	62	88	98	56	72
% of farmers that were seed multipliers	0.7	5	1.8	0	2.3	6	0	0	0	0.5	0.9

Source: Master plan field survey results (2009

Access to Quality Seed

According to farmers the most important attributes that comprised good quality seed were high yields (32%), many healthy eyes (23%), medium to small sized tubers (15%) and seed from healthy mother plant (12%). Shortage and high prices were the main challenges of accessing good quality seeds, as reported by 40% and 37% of farmers, respectively. Other challenges included lack of knowledge on quality seed (14%) and the distance to the quality seed (12%) with differences that transverse districts. Unavailability of quality seed was a problem to the highest number of farmers in Keiyo Marakwet (55%) and Meru (52%) and to the lowest number in Kiambu (24%) which is close to KARI-Tigoni the main sources of certified seed and other interventions on quality seeds. High seed cost was mainly a problem to more farmers in Mt Elgon (52%) and a lesser problem in Kiambu and Narok where it was cited by only 23% of farmers (Table 16)

Table 14: Constraints faced by potato farmers on accessing quality seed

District	Meru	Keiyo Marakwet	Mt Elgon	Nakuru	Narok	Bomet	Nyandarua	Nyeri	Taita	Kiambu	Overall (combined
Seed unavailable	52	55	48	33	37.5	37.5	31	44	74	24	40
Quality seed are expensive	43	45	52	39	23	37.5	49	29	58	23	37
Lack of knowledge	10	22.5	23	2.5	22	25	14	8	31	18	14
Distance to source of quality seed	5	15	32	14	20.5	25	14	7	21	2	12
Poor roads	1	35	25	1	8	4	0	0.4	0	0	

Source: Master plan field survey results (2009

On average, the higher the quality of seed the further the farmers had to travel to obtain it. Although distance travelled varied across districts farmers on average had to travel 142 km to

source for certified seed compared to 37 km for clean seed and 18 for positively selected seed. Farmers sourcing for farmer seed travelled the shortest distance. This means reducing distance travelled when sourcing seed through improved distribution is critical in improving access to quality seed (table 16).

Table 15: Distance traveled to acquire different types of seeds

District	Meru	Keiyo Marakwet	Mt Elgon	Nakuru	Narok	Bomet	Nyandarua	Nyeri	Taita	Kiambu	Overall (combined
Certified seed	207.7	205.0	-	87.3	200.0	212.5	114.6	-	7.0	12.1	124.2
Clean seed	28.9	4.3	-	26.0	2.1	175.0	73.4	-	27.2	-	37.3
Positively selected seed	13.0	-	-	-	1.3	-	1.0	16.2	50.7	-	18.3
Farmer seed	7.4	15.9	6.5	7.4	3.4	4.4	2.7	6.2	33.1	8.5	7.9
All seed types	13.7	36.1	6.5	13.5	5.4	32.3	11.4	7.5	35.6	8.6	13.2

Source: Master plan field survey results (2009

Willingness to pay for quality seed

Concept of contingent valuation method (CVM) was used to gauge how farmers perceive the quality seed and how much farmers were willing to pay for each type of seed. Farmers were asked to indicate the maximum amount they were willing to pay for each type of seed. The contingent valuation method involves directly asking people, in a survey, how much they would be willing to pay for 'new' commodity or service such as a specific environmental service[2]. It is called "contingent" valuation, because people are asked to state their willingness to pay, *contingent* on a specific hypothetical scenario and description of the environmental service. The contingent valuation method is referred to as a "stated preference" method, because it asks people to directly state their values, rather than inferring values from actual choices, as the

[2] http://www.ecosystemvaluation.org/contingent_valuation.htm#over:dated August, 2009

"revealed preference" methods do. The fact that CVM is based on what people say they would do, as opposed to what people are observed to do, is the source of its greatest strengths and its greatest weaknesses.

On average farmers were willing to pay more for certified, clean and positively selected seeds than for the farmer seed which indicate farmers attribute more value to quality seeds (Table). Certified seed emerged as the most valued seed in all district save in Nyandarua where farmers valued clean seed slightly higher than certified seed.

Table 17: Prices farmers are willing to pay for various types of seeds

	Meru	Keito-Marakwet	Mt Elgon	Nakuru	Narok	Bomet	Nyandarua	Nyeri	Taita	Kiambu	Total
Mean price (Kshs/kg)											
Certified seed	32.1	29.7	28.8	17.4	13.1	24.2	18.4	17.8	26.1	20.5	18.8
Clean seed	31.0	19.3	20.0	13.1	12.0	19.9	19.1	13.9	33.3	16.3	16.3
Positively selected	25.4	18.8	10.3	12.9	11.2	16.3	16.4	11.9	27.0	12.0	15.7
Farmer seed	22.0	19.2	17.9	9.6	11.1	12.6	12.5	10.4	28.9	17.8	14.9
Proportion quality seed to farmer seed											
Certified seed	1.6	1.6	1.9	2.0	1.5	2.0	1.8	2.0	0.9	1.8	1.9
Clean seed	1.5	1.0	1.0	1.5	1.4	1.6	1.9	1.8	1.1	1.7	1.7
Positive selected	1.2	1.0	0.7	1.4	1.4	1.3	1.5	1.4	0.9	1.3	1.4
Farmer seed	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Source: Master plan field survey results (2009)

Farmers were willing to pay more for certified seed than for farmer seed, to an extent of farmers in some districts (Nakuru and Nyeri) willing to pay twice as much. Proportionately, farmers nationally were willing to pay for certified seeds 1.9 times the price of the famer seeds (Figure 2). Similarly, farmers were willing to pay for clean seed 1.7 times the price of farmer seed. This indicates that farmers recognized the importance of good quality seed in potato production and were willing to pay a premium for quality seed.

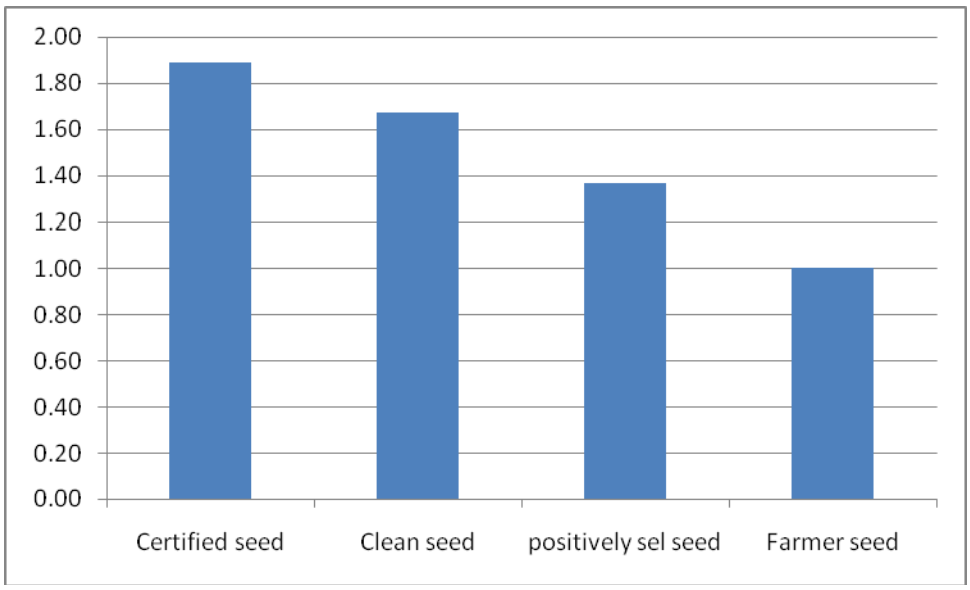


Figure 3: Proportionate price farmers were willing to pay for quality seed

To assess the suitability of the elicited WTP in estimating demand a truncated regression model was used. In the regression WTP was used as the dependent variable while a set of explanatory variables were explored to evaluate their capacity to explain the expressed willingness to pay and a few variables were used as controls. Dummy variables representing different communities (districts) were used to control for agro-ecological differences in each community and community fixed effects.

Table 27 shows the results of regression analysis which had a good fit with Wald test and value of sigma being very significant. The results indicated that having used certified seed before did not have significant effect on the WTP for the seed. Although this may be surprising one interpretation could be related to the quality of the "certified" seed experienced before by respondent farmers. Not having a proper high quality seed may have resulted in no increase of potato yields. Other interpretation is that even those who had no experience with certified seed could have same impression about the certified seed (good or not good) than the people who experienced this seed. The variable that influenced the willingness to pay for certified seed highly is having received training, which would imply that trained farmers were more aware of the importance of a good seed management and were willing to pay more for certified seed.

Although distance of the respondent to the source of seeds seemed to be marginally insignificant it was clear that the further the place to the seed source, the higher the WTP for certified seed, which could be interpreted as effect of transport cost.

Surprisingly, being a male significantly reduced the WTP for certified seed, which means that women were willing to pay more for certified seed. The other significant variable is age and the positive sign means the older the respondent the greater the WTP for the certified seed. Having used fertilizer or manure did not seem to affect the WTP.

Using the concept of willingness to pay and the approach used by Rapport et al (2002) and Goolsbee (2001) in estimating market demand for broadband services and demand for DVD the demand for certified seed was estimated based on the proportion of farmers willing to pay minimum of Kshs 25 per Kg. Estimates of WTP are important in providing direct guidance for decisions associated with product pricing, marketing and positioning and also in guiding public debate. The result indicated that at least 7.4% of farmers were willing to buy certified seed equivalent to 31,677 tons, grown in an estimated 10% of total potato area (Figure 6). Although this was the estimated demand for certified seed in year 2008, the Master plan recognizes the challenges of upgrading the level of use from 1% to 10% and used level of 10% as the targeted level in the five year planning period. The use of conservative level is borne from the realization that countries that have invested heavily for long time in the formal seed sector have had challenges in reaching the level of 10% (Table 26).

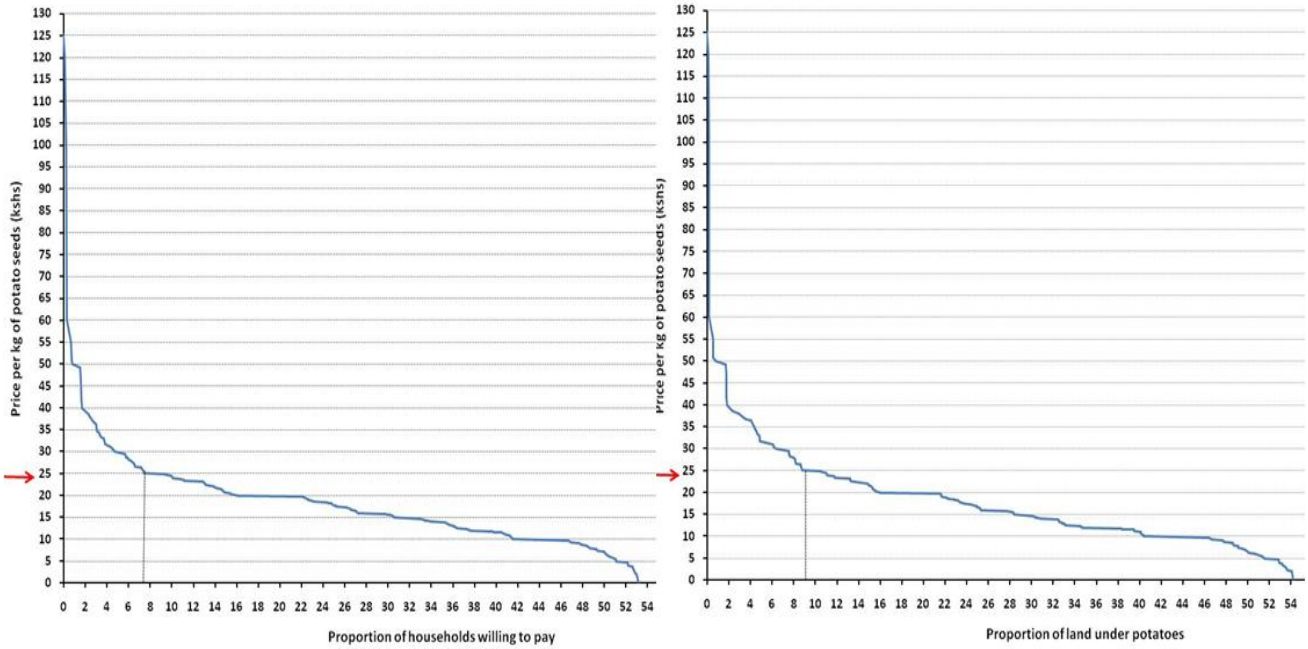


Figure 4: Demand curves for certified seed using willingness to pay

Table 16: Truncated regression results

Limit: lower = truncated Number of obs = 623

upper = +inf Wald chi2(19) = 63.37

Log likelihood = -2350.7773 Prob > chi2 = 0.0000

WTP	Coefficient	Std. Err.	z	P>z
Used certified seed	1.074837	5.582324	0.19	0.847
Received potato training	4.575902	1.871912	2.44	0.015
Distance to seed source	0.057678	0 .050615	1.14	0.254
Male	-3.741196	1.973479	-1.90	0.058

Age	0.138228	0.058936	2.35	0.019
Years of education	0.0883639	0.1972691	0.45	0.654
Used fertilizer	1.925966	2.223205	0.87	0.386
Used manure	1.331735	2.423045	0.55	0.583
Farm size	-0.0421824	0.0755285	-0.56	0.577
Potato for income	2.980892	2.054085	1.45	0.147
Family size	-.0803572	0.1248853	-0.64	0.520
Meru	2.762646	8.926488	0.31	0.757
Keiyo	9.60489	10.31155	0.93	0.352
Taita	-10.92825	17.09865	-0.64	0.523
Nakuru	-8.398678	4.02459	-2.09	0.037
Narok	-24.50188	10.7921	-2.27	0.023
Bomet	-8.00497	12.66179	-0.63	0.527
Nyandarua	-10.21141	5.199508	-1.96	0.050
Nyeri	-11.2122	4.323624	-2.59	0.010
Constant	8.555998	5.440655	1.57	0.116
/sigma	15.08416	.7616702	19.80	0.000

Farmer suggestions on how to improve availability of quality seed

Key solutions suggested by farmers to improve their use of quality seed are provision of low priced seed (25%), provision of high quality seed (24%), provision of more seed stations (23.5%) and training of farmers on high quality seed (23%) (**Table18**)

Table18: Farmer suggestions on how to improve their use of quality seed

District	Meru	Keiyo Marakwet	Mt Elgon	Nakuru	Narok	Bomet	Nyandarua	Nyeri	Taita	Kiambu	Overall (combined districts)
Provide quality sees at low prices	17	23	25	29	9	27	41	23	24	26	25
Avail quality seed	28	34	34	16	19	25	13	28	57	20	24
Provide more quality seed stations	17	25	30	28	26	40	30	28	18	9	23.5
Provide more training on quality seed	28	53	50	2	26	33	21	21	44	16	23

Source: Master plan field survey results (2009)

Acreage under potato and output

In 2008, Kenya produced 1,301,704 tons of potato from 158,386 ha, indicating a national yield of 8.2 tons per ha. Although this yield is slightly higher than the 2007 yield of 6.77tons/ha from FAO's estimated output of 120,000 tons in 800,000 ha it is still far much lower than the potential yield of 25 tons/ha from a progressive farmer under rain fed condition. District

acreage under potato varied with the highest acreage found in Narok (28,736ha) followed by Nakuru (18,322ha), Nyeri (14,809) and Meru (12,193). The highest yield of 11 tons/ha was in Narok, Keiyo Marakwet, Mt Elgon and Bomet and the lowest was in Kiambu at 3 tons/ha (Table).

Table 17: Acreage, yield and output from the major potato producing districts

District	Meru	Keiyo Marakwet	Mt Elgon	Nakuru	Narok	Bomet	Nyandarua	Nyeri	Taita	Kiambu	Total from 10 top producing	Nationally
Total Ha	12192.6	9053.2	4817.2	18322.2	28736.3	4245.8	13986.1	14809.1	2307.1	8023.1	116493	158,386*
Tons/ha	9.9	11.1	11	9.2	11.2	11	7.6	6.7	1.9	3.1	9	8.2**
Output (tons)	120631	100496	52903.5	167711	322535	46790.1	106241	99436.6	4421.3	25179.7	1052091	1301704

*****Extrapolated from MoA data of 2004-2006 which shows that the top 10 potato producing districts produced 73.55% of the total national potato acreage

******Extrapolated from MoA data of 2004-2006 which shows that national potato yield was 91% of the top 10 potato producing districts.

Potato Storage and Method of Storage

Most farmers (90%) stored seed and every single farmer in Bomet stores seed whereas Meru had the least (72%) number of farmers storing seeds. Farmers store seed for an average of 138 days with Meru farmers storing for the longest period (272days) vis-a- vis Narok farmers (40 days) although the vast majority (96%) had not been trained on Diffused Light Stores (DLS). There is thus a dire need for training on DLS as only a marginal number of farmers have been trained in all the districts despite the importance placed on seed storage (Table).

Table 18: .Storage practices and training

	Meru	Keiyo Marakwet	Mt Elgon	Nakuru	Narok	Bomet	Nyandarua	Nyeri	Taita	Kiambu	Total
Farmers storing seeds (%)	72	84	89	91	99	100	98	95	89	84	90
Average storage period (days)	272	181	145	125	40	76	77	90	150	202	138
Farmers trained on DLS (%)	11	4	9	2	2	2	3	5	2	2	4

A quarter of all farmers store their seed in a dark store whilst a fifth of them store their seed in a store that allows light to enter. A few (12%) leave their seed in the field covered whilst a small minority (9%) stores their seed in a dark place in the house. In the various districts seed storage in a dark store was a more rampant practice in Nakuru (38%) and Bomet (37.5%). Storage in a store allowing light prevailed in Keiyo Marakwet (44%) and Mt Elgon (36%). Storing seed covered in the field was customary in Narok (59%) and Mt. Elgon (32%). Storing seed in a dark place in the house was common in Taita (29%) and Mt Elgon (27%) (Table).

Table 19: Potato storage methods (% of farmers)

District	Meru	Keiyo Marakwet	Mt Elgon	Nakuru	Narok	Bomet	Nyandarua	Nyeri	Taita	Kiambu	Overall (combined
Storing seed in a dark store	25	20	14	38	20.5	38	21	26	26	16	25
Storing in a store allowing light	23	44	36	25	16	46	22	10	6.5	12	20
Storing seed covered in a field	8	10	32	15	59	0	13	5	10	1	12
Storing in a dark place in the house	4	16	27	8	14	17	3	9	29	3	9

Training on DLS would be beneficial to farmers in all the districts since some only those already storing in a store allowing light would need a little improvement, the rest would need training and demonstration on DLS to ensure proper seed handling and storage.

Dormancy breaking

On the whole the 2 most popular methods used to break seed dormancy were waiting (48%) and putting the seed in bags (32%) with differences in various districts. The use of a pit to break seed dormancy was highest in Meru (33%) while farmers who put the seed in a warm place to break dormancy were found mainly in Keiyo Marakwet (49%){table 23}.

Table 23: Methods farmers use to encourage potato seeds sprouting

District	Meru	Keiyo Marakwet	Mt Elgon	Nakuru	Narok	Bomet	Nyandarua	Nyeri	Taita	Kiambu	Overall (combined

Putting seed in a pit to break dormancy	33	14	23	5	1	4	12	5	6.5	5	10
Putting seed in bags to break dormancy	41	33	29	16	7	27	31	40	60	37	32
Just waiting until seed breaks dormancy	33	56	52	68	75	63	38	39	21	45	48
Putting seed in a warm place to break dormancy	8	49	36	22	6	15	19	15	24	9	17

Farmer Training

A little less than half (48%) of farmers had attended agricultural training and only a few (20%) had been trained on aspects of potato with only a small minority (7%) having received regular advice/training in the last year. The districts where more than half of the farmers have received agriculture training were Nyeri (80%) and Meru (57%). In the other districts most of the farmers have not received agriculture training with the most disadvantaged district being Mt Elgon (only 21% trained) and Narok (only 27% trained). Potato training is most lacking in Mt Elgon (only 5% trained), Bomet (only 6% trained) and surprisingly Kiambu (only 8% trained). Regular potato training in the last year is most deficient in Narok (1% trained in last year), Bomet (2%), Kiambu (2%), Taita (3%), Mt Elgon (4%) and Nyandarua (4%){table 24}.

Table 24: Farmer training (% of farmers)

District	Meru	Keiyo Marakwet	Mt Elgon	Nakuru	Narok	Bomet	Nyandarua	Nyeri	Taita	Kiambu	Overall (combined
% of farmers that have received agricultural training	57	44	21	36	27	37.5	37	80	40	45	48
% of farmers trained in potatoes	44	22.5	5	20	14	6	17	26.5	13	8	20
% of farmers trained on potatoes who were trained in the last year	21	10	4	6	1	2	4	10	3	2	7

In general training on any aspect of potato is sorely lacking in most districts and most farmers in most district rarely getting regular training on potatoes

Conclusion and recommendations

In Kenya, potato is highly positioned as both a food and an income source with average seasonal farm acreage of 0.3 ha. It is planted twice and occasionally three times in some districts with variety acreages and seed type used varying from district to district. The national yield of 8.2 tons per ha for 2008 remains far much lower than the potential yield of 25 tons/ha from a progressive farmer under rain fed condition indicating a high need to address the challenges in the sub-sector.

Farmer seed was the most commonly planted type of seed and constituted 95.5% of total seed area countrywide while quality seed which comprises certified seed, clean seed and positively selected seed, constituted only 4.5%. Out of the quality seed area, 1.2% was certified seed, 1.5 was clean seed while 1.8% was positively selected seed. In terms of use only 7.9% of farmers used these quality seed, 1.3% used certified, 1.9% used clean and 3.4% used positively selected seed.

Use of certified seed was unnoticed in Mt Elgon, Bomet and Nyeri; use of clean seed was unnoticed in Mt Elgon while there was less than 1% use of clean seed in Nakuru, Nyandarua, Nyeri and Kiambu; use of positively selected seed was unnoticed in Keiyo Marakwet, Mt Elgon, Nakuru and Kiambu. There was consequently a gaping opportunity for training farmers in use of certified, clean and positively selected seeds in most districts.

Tigoni acreage was highest over ally and had the highest variety acreage in Keiyo Marakwet, Nakuru, Nyandarua and Taita ; Asante is highest in Meru; Thima thuti in Narok and Nyeri; Nyayo in Kiambu; Arka in Mt Elgon and Dutch Robjyn in Bomet. Only a few of these farmer preferred varieties (namely Tigoni, Asante and Dutch Robjyn) were in the formal seed system and thus available as certified seed. For the other varieties there were no options but to wholly rely on seed of unknown quality.

There is therefore a need for collection, cleaning and releasing of farmer favored varieties that are highly esteemed by farmers but which are not available as certified seed such as Thima Thuti, Arka, Nyayo, Meru Mugaruro, Shangi, Purple Tigoni, Kanyoni etc. Variety identification and lineage follow-up should also be conducted in all parts of the country to ensure that one

variety does not go by different names or many different varieties do not bear the same name in different regions.

Bacterial wilt was a grim reality for the large majority of farmers (> 65% of farmers) in each district, with knowledge on the way the disease is spread varying from district to district. Most Nyeri farmers (62%) identifying infected seed as means of spreading the disease while a sobering few in Narok (10%) were able to make the same identification. About half of Nyandarua farmers (51%) cited infected soil as a means of spreading bacterial wilt while only a minority of Keiyo Marakwet farmers (22.5%) had such knowledge. There is therefore a gap in the knowledge of bacterial wilt spread. In terms of control, a fair number of farmers in Mt Elgon (63%), Narok (49%) and Keiyo Marakwet (44%) sprayed their crop against bacterial wilt and since bacterial wilt is mainly seed or soil borne this could mean inappropriate use of their scarce resources. Seed renewal as a control measure was mentioned by hardly any of the farmers (<10%) in all the districts.

This calls for trainings and demonstrations by experts to create awareness to farmers of what bacterial wilt is, how it is spread and are the appropriate and effective control measures.

Seed sourcing was a big challenge and only a few farmers said they knew a trusted seed source (31%) while most farmers said they had problem getting quality seed (72%). Additionally, in a number of districts (Nakuru, Nyandarua, Nyeri, Taita, Meru and Kiambu) there were less than 1% of seed multipliers. Limitations faced by farmers in accessing quality seed included unavailability (40%), high cost (37%), lack of knowledge (14%), distance to the seed (12%) and poor roads (%). Solutions offered by farmers to increase access of quality seed included lowering the price of quality seed (25%); increasing number of seed stations (23.5; and providing training (23%).

On average, farmers had to travel 142 km to source for certified seed compared to 37 km for clean seed and less than 20 km for positively selected seed and farmer seed. This means

reducing distance of source for certified seed through improved distribution was critical in improving its access

Proportionately, farmers nationally were willing to pay for certified seeds 1.9 times the price of the famer seeds; for clean seed 1.7 times the price of farmer seed; and for positively selected seeds 1.4 times the price of farmer seed. This indicates that farmers recognized the importance of good quality seed in potato production and were willing to pay a premium for quality seed. This calls for a more elaborate study to estimate the actual demand for quality seed.

Seed storage was common and most all farmers' stored seed (90%). However, only 4% were trained on the use of improved seed store (DLS). This means that farmers store in less than ideal conditions affecting the quality and viability of their seed at planting and consequently the yields. Storing in dark stores (25%) or dark houses (9%) lead to seed producing few, long, weak sprouts that either break at planting or give poor germination and resulting to low yields. Storing seeds in the field while covered (12%) leads to poor sprouting as well as high rots. The need for use of DLS at the district level is thus critical and thus training in DLS is paramount.

Less than half of all farmers (48%) had received agriculture training but less than half of these (20%) had been trained in any aspect of potato production with only a minority (7%) having trained in the last twelve months preceding the survey. Most farmers thus produce potatoes using knowledge garnered over the years, from parents or from neighbors' and this production knowledge may or may not be optimal depending on the source.

Proper potato production information should be disseminated to farmers so that potatoes are produced optimally. Trainings and demonstrations on quality seed (certified, clean and positive) is essential at the district or even at a lower level (location or village level) as most farmers were unaware of the need to use the various types of quality seed and the benefits that accrue from use of such seed.

This study indicates there are diverse opportunities in different aspects of the seed value chain touching on aspects of production, storage marketing and distribution.