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The Value of Seed Potatoes from Four Systems in Kenya

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Abstract Although potatoes are the second most valuable crop in Kenya, poor seed potato quality has limited industry expansion. The objectives of this study were to describe the seed potato system, identify problems, determine use of high-quality seed and estimate farmer willingness to pay (WTP) for different types of seed. Data was collected from interviews, forums and surveys. A contingent valuation method (CVM) model was also developed to analyze the factors that influence farmer WTP. It was found that the seed system consists of three sub-components: Formal, Semi-Formal and Farmer. More than 96 % of Kenya seed potatoes were produced in the Farmer category, and were considered to be poor quality. Growers identified bacterial wilt, viral diseases and late blight as the most serious problems. The WTP model revealed that farmer age, distance to seed source, potato training, gender and region were statistically significant explanatory variables. The study recommends that training be conducted to increase production of "clean seed" and "positively-selected seed" in the Semi-Formal part of the seed system.

Resumen Aun cuando las papas son el segundo cultivo más valioso en Kenia, la pobre calidad de la semilla ha limitado la expansión de la industria. Los objetivos de este estudio fueron la descripción del sistema de semilla de papa, identificar los problemas, determinar el uso de semilla de alta calidad y estimar la disponibilidad del productor para pagar (WTP) por los diferentes tipos de semilla. Se colectaron datos mediante entrevistas, foros y encuestas. También se desarrolló un modelo de método de evaluación contingente (CVM) para analizar los factores que influencian la WTP del productor. El sistema de semilla consiste de tres sub-componentes: Formal, Semi-Formal, y del Agricultor. Más del 96 % de la semilla de papa de Kenia se produjo en la categoría del Agricultor, y se consideró de baja calidad. Los productores identificaron marchitez bacteriana, enfermedades virales y tizón tardío como los problemas más serios. El modelo WTP reveló que la edad del agricultor, la distancia a la fuente de semilla, el entrenamiento en papa, el sexo del productor y la región, fueron variables estadísticamente significativas que lo explicaban. El estudio recomienda que se haga capacitación para incrementar la producción de "semilla limpia" y "semilla selectivamente seleccionada" en la parte Semi-Formal del sistema de semilla.

Keywords Formal seed system · High-quality seed · Willingness to pay

W. Kaguongo
National Potato Council of Kenya (NPCK), P.O. Box 29982-00100, Nairobi 00100, Kenya
e-mail: nkaguongo@npck.org

G. Maingi
Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Private Sector Development in Agriculture (PSDA), P.O. Box 41607, Nairobi, Kenya

I. Barker
Syngenta Foundation for Sustainable Agriculture (SFSA), WRO-1002.11.54 Schwarzwaldallee, 215 CH- 4002 Basel, Switzerland

N. Nganga
Kenya Agricultural Research Station (KARI), P. O. Box. 338-00217, Limuru, Kenya

J. Guenthner (✉)
Department of AERS, University of Idaho, Moscow, ID 83844-2334, USA
e-mail: jguenthner@uidaho.edu

Introduction

Potatoes in Kenya

Potato ranks as the second most important food crop in Kenya, after maize (Guyton et al. 1994). It is both a staple food and a cash crop for many families in Kenya. Potatoes play an important role in food security, poverty alleviation and income

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generation. The potato value chains also provide jobs for many Kenyans (Kabira et al. 2007). The ware potato value chain brings potatoes to urban areas where consumers buy them as an inexpensive food. Potatoes are also an important raw material for an expanding fast food industry. About 65 % of potatoes handled by Kenyan urban traders is sold as cooked products in quick service restaurants (QSRs) and street stalls (PRAPACE and ECAPAPA 2004; Kirumba et al. 2004).

Potato production in Kenya occurs mainly in the highlands of the Central, Eastern and Rift Valley regions, in the Mau range and the slopes of Mt. Kenya (Fig. 1). Farmers in other regions such as Mt. Elgon in the Western province and Taita Taveta on the southern border with Tanzania have also started growing potatoes on a commercial basis.

Kenya potato yields have been declining at a rate of 11 % per year (FAO 2010). This decline is attributed to adverse weather conditions, declining soil fertility, use of low yielding varieties and poor quality seed potatoes (Kaguongo et al. 2008) as well as high occurrence of diseases and pests. Potato growers in Kenya use a range of sources for seed potatoes, but certified seed is scarce. While certified seed potatoes meet 20 % of needs in China, 60 % in Argentina and 99 % of needs in the Netherlands, it makes up only 1 % of needs in Kenya (Barker (2008), Huarte (2008).

Seed Potato Systems

A formal seed potato production system, modeled after European systems, began to develop in Kenya in the 1950s. In the 1960s Kenyan government, with technical assistance from Germany and the UK, started programs in variety screening, plant breeding and seed multiplication (D rr and Lorenzl 1980). A basic seed production station was established at the Kenya Agricultural Research Institute (KARI) at Tigoni. By the 1980s the seed system was operating with technical and organizational efficiency, and was controlled totally by the public sector.

In the 1990s many elements of the potato development system collapsed, mainly due to political interference in the land allocation. Many of the public farms, including research stations were allocated to private individuals, who used it for other purposes. This led to losses of potato research and seed potato production capacities. As a result, an informal farmer-based seed potato system developed to meet grower needs. It evolved with help from government and development agents key among them GIZ, CIP and USAID.

By 2005 Kenyan farmers sourced 94 % of their seed potatoes from untrained growers in the informal seed system (Kaguongo et al. 2008). Although small quantities of high-quality seed were available from a few trained growers, supplies have been limited by institutional, infrastructural, regulatory and knowledge barriers.

In recent years the Kenyan government, development partners (mainly CIP, GIZ and USAID), and private business sector have teamed up to promote production and use of high-quality seed potatoes. Improved technologies have included rapid seed multiplication, aeroponics and positively selected seed. The National Potato Council of Kenya (NPCK), a multi-stakeholder organization which was formed in 2011, is now responsible for coordinating seed and other potato industry programs.

The best combination of formal and informal seed potato systems in Kenya is not established yet. Most developing countries have had limited success in building a dominant formal seed system. Formal systems can lock farmers into high input costs and increase planting of inappropriate varieties (Boef de et al. 1995). According to Thiele (1998) one challenge of formal seed schemes is to supply small-scale farmers who require small quantities of seed intermittently and live in areas with poor road network. As a stopgap measure in improving use of quality seed stakeholders developed a middle class seed category called "Clean" seed which is similar to "Quality Declared Seed (QDS)". The "Clean" seed is produced starting with certified seed and using agreed guidelines but no inspection is conducted by a regulatory organization. This subsystem forms what is referred to as semi-formal subsystem. In Kenya, the formal and semi-formal subsystems supplied less 5 % of required seed while informal or farmer subsystems supplied over 95 % (Fig. 2).

The main weakness of informal seed systems is the low yields caused by planting poor quality seed (Douglas 1980). Since this weakness is a problem in Kenya, improvements in the informal systems will definitely increase potato yields for Kenyan potato growers. Researchers have suggested a need to recognize and strengthen farmer-based seed systems and to link them as complements to formal systems (Thiele 1998; Tripp 1995; Jaffee and Strivastava 1992).

Recent Research

A survey conducted by International Potato Center on potato scientists to identity areas for potato improvement in developing countries ranked improved supply of high-quality seed as third highest (Fuglie 2007). Bacterial wilt control was ranked fifth. In sub-Saharan Africa the top priority was control of bacterial wilt.

Another recent study interviewed potato growers in East Africa to identify areas for potato improvement (Gildemacher et al. 2009). The researchers found that more than half the growers plant their entire crops with farm-saved seed potatoes. They recommended that growers be trained to manage bacterial wilt and viruses. They also encouraged private investment to enhance the seed potato system.

In Ethiopia, researchers identified three categories of co-existing seed potato systems (Hirpa et al. 2010). The

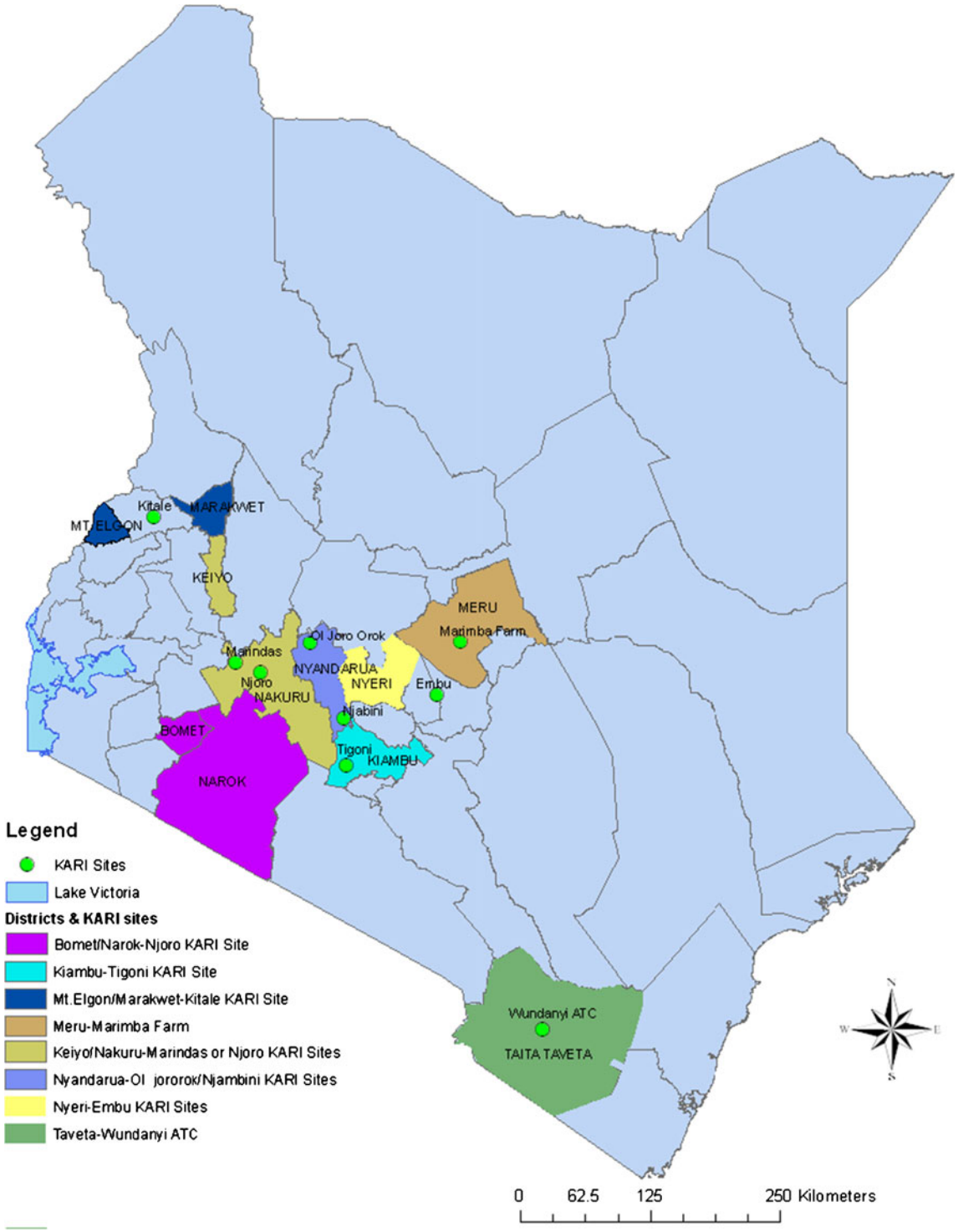

Fig. 1 Potato production areas in Kenya

traditional formal system was much too small to improve the poor-seed-quality situation. The informal farm-saved seed system provided most of the planting material and was characterized by poor quality. The authors recommended that farmers be trained and that quality control programs be developed.

Researchers in Kenya studied the impact of positive selection on seed potato quality in non-formal seed potato systems (Schulte-Gelderman et al. 2012) Positive selection is the practice of choosing healthy-looking mother plants to be harvested for seed potatoes. They found that positive selection reduced the incidence of virus diseases and increased yields an average

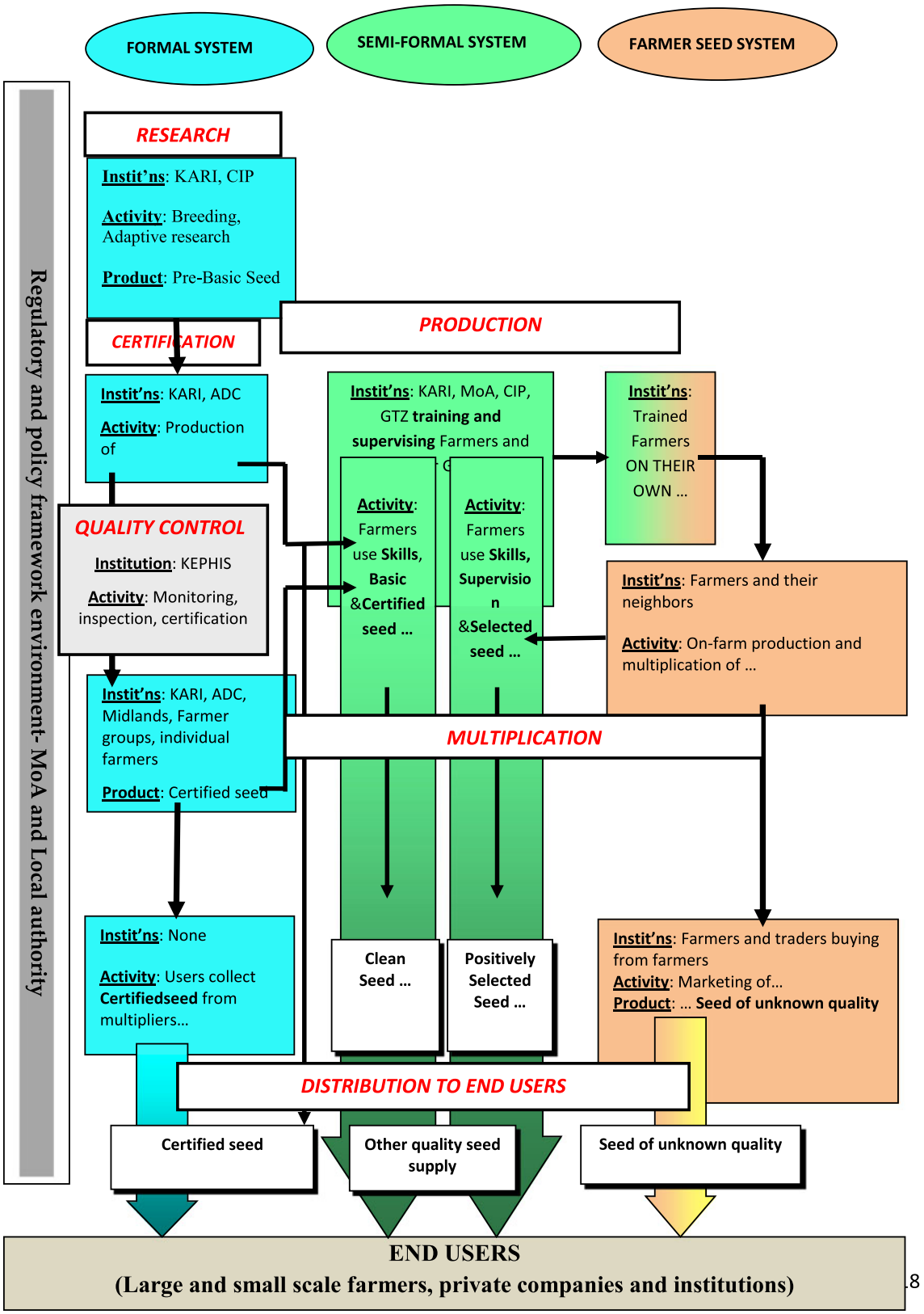

Fig. 2 Kenya seed potato framework

of 30 %. They concluded that positive selection can benefit small producers and that it should be incorporated into extension programs. It also enables the resource poor farmers to use more reliable own seed for at least 2 to 3

seasons without having to buy expensive fresh seed every season

Objectives

The overall objectives were to establish the status of the Kenya seed potato industry and evaluate the use of high-quality seed. Specific objectives were to:

1. Describe the overall seed potato production and distribution system
2. Identify seed potato issues and problems
3. Determine the level of use of high-quality seed
4. Evaluate farmer's willingness to pay for different types of seed.

Methods

To accomplish the objectives a triangulation approach was used, applying both heuristic and analytical methods as suggested by Webb et al. (1966). We used primary data from interviews, meetings and surveys for all four objectives. For the fourth objective we also built a statistical model to better understand willingness to pay for seed potatoes

Data Collection

Data was collected between February and March 2008 in three stages. The first stage involved value chain analysis in which key players in the seed potato sub-sector and their functions were identified and interviewed. The second stage involved conducting diagnostic surveys in all ten major potato-producing Counties to get an overview of seed potato production, multiplication and distribution.

The third stage involved collecting household data from farmers to help achieve objectives 2–4. The survey team randomly selected 1337 farmers for interviews. The sample comprised about 0.7 % of all potato-producing households. A questionnaire with both closed and open questions was used. The information collected included awareness of the need to use high-quality seed, availability of high-quality seed, current prices for different seed types and maximum prices farmers were willing to pay for each type of seed.

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

Model

The analysis used the contingent valuation method (CVM) to gauge how farmers perceived the value of seed potatoes. CVM involves asking people what they would be willing to pay for a 'new' commodity or service. It is called 'contingent' valuation because participants are asked to state their willingness to pay (WTP), *contingent* on a specific hypothetical scenario or description of the alternative.

WTP has been used for the valuation of public goods such as environmental protection. In recent years, it has also been applied in market research for private goods (Buhr et al. 1993; Lusk and Hudson 2004). According to Rappoport et al. (2002) it is important for WTP researchers to use products that are available and understood by participants in the survey. It was assumed that the potato growers understood the different types of seed potatoes available in Kenya.

It was hypothesized that each farmer i has a willingness to pay for certified seed WTP_i^* which is related to the farmer's and farm's characteristics X_i as follows:

$$WTP_i^* = X_i\beta + \varepsilon_i$$

Where β is a vector of coefficients, ε_i is the stochastic term assumed to have mean zero and is normally distributed. The estimation of the model was done using double-hurdle regression (Cragg 1971), a modification of the model used by Tobin (1958). The first hurdle, which is truncated at WTP $\leq$0,determines the willingness to pay (participate in the market). The second hurdle establishes the amount to pay contingent upon clearing the first hurdle (Martinez-Espineira 2006; Mabiso 2005; Musengezi et al. 2006). A set of explanatory variables were explored to evaluate their capacity to impact WTP. Dummy variables representing different counties were used the capture the influence of agro-ecological differences.

During data collection farmers were asked a hypothetical open-ended question regarding how much they would be willing to pay for each type of seed. Although farmers were not first asked whether they were willing to buy various types of seed, it was assumed that once a farmer offered a price that implied a willingness to participate in the market. The amount they offered reflected their perceived value of that seed type.

Results

Farmer Characteristics

The households interviewed had a mean family size of 5.7. The majority of households were male headed (78.1 %). Overall, farmers in the 10 districts owned an average of 1.7 ha of land and cultivated an average of 1.3 ha. Farmers had mean experience of 14 years in potato production, with the most experienced farmers in Meru (19 years) and the least experienced located in Nakuru, Bomet and Taita taveta (8 years).

Potato was the most important cash crop (ranked first by 46 % of farmers) followed by maize (ranked first by 12 %). Most of the potato producers (63 %) sold more potatoes than they consumed although various districts differed in this aspect. More than 90 % of farmers in Keiyo Marakwet, Narok and Bomet districts sold more than they consume while only 22 % in Kiambu did that.

Varieties Grown

The most commonly grown varieties were Tigoni (cultivated by 25.7 %), Nyayo (cultivated by 24.8 % of potato farmers) and Thima thuti (22.7 % of farmers). Similarly, the highest proportion of land was under Tigoni (20.7 %) followed by Thima Thuti (20.2 %) and Dutch Robjyn (10.5 %). Although a high proportion of farmers cultivated Nyayo it occupied only 9.5 % of total land, indicating that many farmers were growing it on smaller farm acreages than either Tigoni or Thima thuti. Widely grown varieties do not always have the highest acreage as, overall, Dutch Robjyn acreage was higher than that of Nyayo even though only 9.6 % of all farmers grow Dutch Robjyn compared to 24.8 % growing Nyayo.

Seed Potato Systems

The study findings indicated that the Kenya seed potato industry consists of three sub-systems: Formal, Semi-Formal and informal (Fig. 3). The functions of the entire system consist of: (1) research, (2) production, (3) certification, (4) multiplication and (5) distribution.

Formal Seed System

This system is characterized by official rules and guidelines from the Kenyan government. It has evolved over the years from various programs funded by government and other development partners. The Formal seed system is the only one of the three involved in the research function (Fig. 3). This includes breeding, adoptive research and agronomic research conducted by KARI-Tigoni and the International Potato Center (CIP).

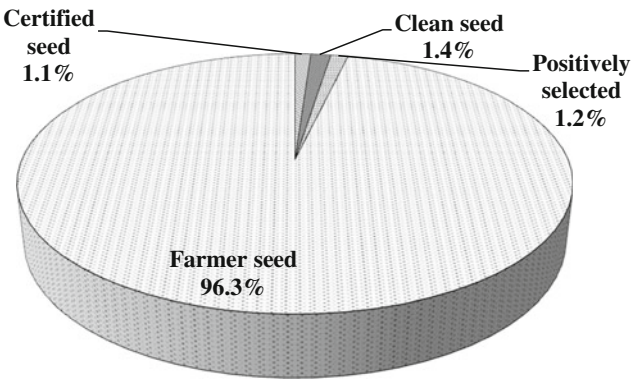

Fig. 3 Proportion of seed potato types planted in Kenya

Production of clean basic seed is mainly a responsibility of KARI-Tigoni. The basic seed is passed on to seed multipliers for bulking and distribution. There are a few certified seed bulking farmers, farmer groups and private companies and one parastatal-Agricultural Development Corporation (ADC). The Kenya Plant Health Inspectorate Services (KEPHIS), a phytosanitary regulatory organization, is in charge of the certification function within the Formal seed system. The distribution function is a weak link of the Formal seed system. Currently, there are no distributors for certified seed causing farmers to travel long distances to source their seed.

Semi-Formal Seed System

Growers in the Semi-Formal System produce two different types of products: (1) clean seed and (2) positively selected seed. Three of the five seed system functions—production, multiplication and distribution—are encompassed in the Semi-Formal System (Fig. 3).

Clean Seed This comprises seed multiplied at the farm level which originates from certified seed. Production practices follow recommendations from farmer training conducted by KARI, Ministry of Agriculture (MoA), Deutsche German Agency for Internal Cooperation (GIZ) and Training of Trainers (TOT). Most guidelines used in production of certified seed are also used in clean seed production. Only sample testing and certification by KEPHIS are omitted. Negative selection is used to remove diseased and weak plants.

The process of producing clean seed is technically backstopped by extension educators from MoA, KARI and other non-government organizations (NGOs). It has been a collaborative effort funded by GIZ and CIP. The seed multipliers receive training on how to produce clean seed from basic or certified seed. Clean seed is not recognized by Kenyan law and currently cannot legally be sold through formal market channels.

Positively Selected Seed These are seed potatoes produced from farmer seed through a process of selecting the best looking plants during vegetative growth by farmers trained on seed selection and management. Although the process of production lacks the stringent procedure and inspection by KEPHIS it offers an opportunity for farmers to control diseases and improve their yields by an average of 30 % per season (Gildemacher et al. 2007).

This process, if well managed, has potential as a stop gap measure to improve seed potato quality outside the formal system. In the short run there is need to support the on-going

efforts by CIP, KARI, MOA, GIZ and USAID in training farmers about positive selection. Although positively selected seed is not tradable it can help boost potato yields significantly in the short run since it is an inexpensive on-farm practice.

Farmer Seed System

This system comprises of seed potatoes obtained from own and neighbor farms and is mainly of very poor quality. In this system no guidelines are followed and no systematic seed selection is done. Most farmers use left-over tubers (after sale or consumption) and unconsciously select small tubers with negative characteristics leading to even lower potato yields in the subsequent season. Farmers generally select small sized tubers for seed and consume or sell the rest.

The situation is worsened by many years of degeneration. This type of seed suffers from pest and disease (especially bacterial wilt and viral diseases) accumulation leading to low yields. It also contributes greatly to the spreading of diseases. It is believed to be the major culprit in the endemic spread of bacterial wilt and leaf roll viruses in most potato producing regions. The seed is sourced at the farm level and is available in ware potato markets.

Seed Potato Problems

The survey included questions about potato diseases. Bacterial wilt was the most prevalent disease, affecting 77 % of potato farmers, followed by late blight (67 %) and viral diseases (12 %). Bacterial wilt was controlled through uprooting (41 %), crop rotation (36 %) and chemical spraying (21 %) although no pesticide is known to be effective. Varieties identified as tolerant to bacterial wilt were Tigoni in Keiyo Marakwet (31 %) and Nakuru (17 %) as well as Arka in Mt Elgon (36 %). A number of farmers believed bacterial wilt was spread mainly through infected soil (41 %) and infected seed (38 %).

Farmers mainly controlled late blight by chemical spraying (55 %) and planting varieties believed to be tolerant to the disease. Many farmers believed that the Tigoni variety was tolerant to late blight, especially in Keiyo Marakwet (38 %) and Nakuru (27 %). Tigoni and Asante are among the CIP varieties introduced into the country mainly due to their resistance to late blight and high yielding attributes.

Only 40 % of farmers renewed seed regularly, and this was mainly when they were changing varieties. Since many farmers used seed from their own harvest and did not have technical training their seed continues to degenerate and to be a source of diseases and pests.

Although 90 % of farmers store seed, only 4 % had been trained on proper seed storage using diffused light stores (DLS). This means training of farmers on use of DLS has potential to improve productivity though maintenance of seed quality and reduced post-harvest losses.

Among the farmers who bought certified seed the average transport distance was 124 km. That suggests that improved seed distribution could lead to increased use of quality seed.

Use of High-Quality Seed

The purpose of Objective 3 was to determine the use of the different types of seed found in Objective 1. From the grower survey it was found that the Informal or Farmer seed system contributed 96.3 % of the total amount of seed potatoes planted in Kenya (Fig. 3). Clean and positively selected seed contributed1.4 % and 1.2 %, respectively. Certified seed is the smallest component at 1.1 %. Use of certified seed and other high quality seed has remained low despite efforts over the years by the government and development partners.

Willingness to Pay

Most farmers surveyed were aware of the importance of high quality seed and were willing to pay some premium for quality. Certified seed emerged as the most valued seed, followed by clean seed (Fig. 4). On average, farmers were willing to pay for certified seed190%of the price of famer seed. Similarly, farmers were willing to pay for clean seed 170 % of 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.

Statistically Significant Variables

The WTP regression analysis revealed factors that influence potato grower WTP for certified seed potatoes. Seven variables were statistically significant at the 94 % level or higher (Table 1). Age had a positive impact on WTP, meaning that the older the respondent the greater the WTP. Surprisingly, being a male reduced WTP, which means that women were willing to pay more. Training was another significant variable.

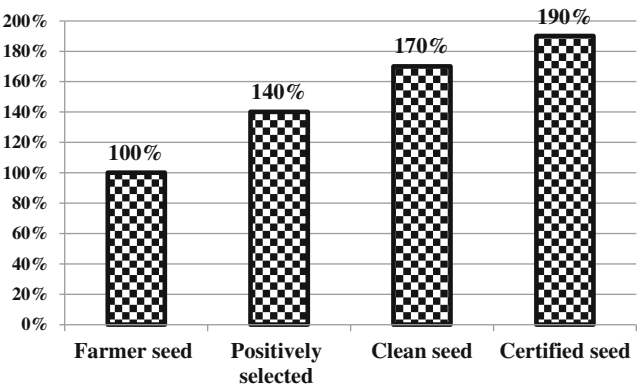

Fig. 4 Potato farmer willingness to pay for four types of seed potatoes (percent of farmer seed price)

Table 1 Farmer characteristics

	Meru	Keiyo_Marakwet	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
Area under potato (ha-Oct–Feb)	0.3	0.5	0.2	0.3	1.2	0.3	0.3	0.2	0.1	0.1	0.3
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

Master plan field survey results (2009)

The positive impact means that trained farmers, who are aware of the importance of a good seed, were willing to pay more for it. The other four variables, all with negative impacts were for four regions. The implication is that farmers from those areas are less willing to pay for high-quality seed.

Two other variables may be considered statistically significant, but at much lower levels. "Potato for income" had a positive coefficient. Apparently, farmers who grew potatoes for sale, rather than for home consumption, were more willing to pay higher prices for high-quality seed. The other variable was the distance of the respondent to the source of seed. The positive impact means that the further the distance to the seed source, the higher the WTP. This would account for distance-based transport costs.

Statistically Insignificant Variables

Family size and farm size were among the variables that were not statistically significant. The study also analyzed three variables regarding potato production practices that were also statistically insignificant. It was hypothesized that previous use of certified seed would have a positive and statistically significant effect. We also thought that use of fertilizer and manure might impact WTP but they did not. Education was another variable that was thought would have a positive impact but had none. The other statistically insignificant variables were regional dummy variables (Table 2).

Discussion

Use of poor quality seed remains a major drawback in Kenya's potato production. The survey confirmed that the Formal seed system fails to provide more than a tiny fraction of Kenya's needs for seed potatoes. The survey also pointed out the importance of training for growers to develop an understanding of the value of high-quality seed. Although formal education was not a statistically significant variable, training was.

Table 2 Willingness to pay regression summary

Variable	Impact
Significant at 94 % or higher:	
Age	positive
Male gender	negative
Received potato training	positive
County - Nyeri	negative
County - Narok	negative
County - Nakuru	negative
County - Nyandarua	negative
Significant at 85 %:	
Potato for income	positive
Significant at 75 %	
Distance to seed source	positive
Statistically insignificant:	
Family size	0
Farm size	0
Used certified seed	0
Used fertilizer	0
Used manure	0
Years of education	0
County - Keiyo	0
County - Bomet	0
County - Meru	0
County - Taita	0

Since males had a lower WTP, a relative lack of male attendance at training programs may be an issue.

Training may become an important catalyst to increasing the amount of high-quality seed planted in Kenya. Capacity restrictions would prevent rapid expansion of the Formal seed system, but the Semi-Formal system may have fewer impediments to growth. Expansion of the Positively-selected seed sector might offer the best opportunities to increase Kenya potato yields in the short run. Extension education methods that include on-farm demonstrations could be effective.

The high incidence of bacterial wilt is a big challenge in seed multiplication. It calls for creating farmer awareness on measures to control the disease. Seed certification regulations include a zero tolerance for bacterial wilt. For viral diseases, such as leaf roll, there is some level of field tolerance (<5 % of growing potato plants in the field). The team recommends testing for bacterial wilt and viral diseases using ELISA or field testing kits for seed multipliers. It also recommends that growers be encouraged to expand use of the Semi-Formal seed system. Clean seed and positively-selected seed could reduce disease incidence, enhance seed availability, increase yields, reduce production costs and improve farm profitability.

One surprising result in the model was that having used certified seed previously had no impact on WTP. Perhaps many of those who had no experience with certified seed had the same impression as those who planted it. Some may have gained that knowledge by observing the use of certified seed on neighboring farms. Another explanation could be related to the quality of the certified seed used by some farmers. Perhaps some respondents thought they planted certified seed, but it may have been incorrectly identified. Since certified seed potatoes are only used in 1.1 % of plantings, some respondents may have been confused about the definition of certified.

Another surprising result is the lower WTP in four important potato-growing regions: Nyeri, Narok, Nakuru and Nyandarua. One possible explanation is that they are contiguous. There may be something in common with the growers, cultural practices, growing conditions or weather that causes the perceived value of high-quality seed to be lower.

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References

Barker, I. 2008. Challenges and opportunities for improving availability of quality potato seed in Eastern and Central Africa. Paper read at Global Potato Conference, 9–12 December 2008, at New Delhi.

Boef de, W.S., T. Berg, and B. Haverkort. 1995. Farmers, crops and landraces: Farmers' roles in the development and conservation of crop diversity. In *Internal discussion paper*. Wageningen: CPRO-DLO Centre for Genetic Resources, Wageningen, Holland.

Buhr, B.L., D.J. Hayes, J.F. Shogren, and J.B. Kliebenstein. 1993. Valuing ambiguity: The case of genetically engineered growth enhancers. *Journal of Agricultural and Resource Economics* 18(December 1993): 175.

Cragg, J.G. 1971. Some statistical models for limited dependent variables with application to the demand for durable goods. *Econometrica* 39(5): 829–844.

Douglas, J. 1980. Successful seed programs. In *A planning and management guide*. Westview Press. Boulder, Colorando: Westview Press.

Dŭrr, G., and G. Lorenzl. 1980. *Potato production and utilization in Kenya*. Centro Internacional de la Papa. Lima, Peru. 133 p.

PRAPACE and ECAPAPA. 2004. *The potato and sweetpotato sub-sector analysis: A review of sub-sector satus, constraints, opportunities and investment priorities. A report submitted to ASARECA, 62p. Seyfu. 2004. Focusing on real challenges and trends in Agricultural Research in the ASARECA region. A paper presented on PRAPACE Planning and Steering Committee.* 16 - 17 February 2004. Mukono, Uganda.

FAO. 2010. FAO Website. http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567. Dated July 2009.

Fuglie, K. 2007. Priorities for potato research in developing countries: Results of a survey. *American Journal for Potato Research* 84: 353–365.

Gildemacher, P., P. Demo, P. Kinyae, M. Nyongesa, and P. Mundia. 2007. Selecting the best plants to improve seed potato. *LEISA Magazine* 23(2): 10–11.

Gildemacher, P., P. Demo, I. Barker, W. Kaguongo, G. Woldegiorgis, W. Wagoire, et al. 2009. A description of seed potato sytems in Kenya, Uganda and Ethiopia. *American Journal for Potato Research* 86: 373–382.

Guyton, B.F., F. Sogo, J. Mogire, and R. Njuguna. 1994. Kenya's Irish potato subsector characteristics, performance and participants' information needs. In *Government of Kenya Market Information System Report No. 94-01*. Nairobi.

Hirpa, A., M. Meuwissen, A. Tesfaye, W. Lommen, A. Lansink, A. Tsegay, et al. 2010. Analysis of seed potato systems in Ethiopia. *American Journal for Potato Research* 87: 537–552.

Huarte, M. 2008. Trends in seed potato production in Latin America. Paper read at Global Potato Conference, 9–12 December 2008, at New Delhi.

Jaffee, S., and J. Strivastava. 1992. Seed system development: the appropriate roles of the private and public sectors. In *World Bank Discussion Papers 167*. Washington DC: The World Bank.

Kabira, J.N., M. Wakahiu, W. Wagoire, P. Gildemacher, and B. Lemaga. 2007. Guidelines for production of healthy seed potatoes in East and Central Africa. In *Kenya Agricultural Research Institute (KARI)*. Kenya.

Kaguongo, W., P. Gildemacher, P. Demo, W. Wagoire, P. Kinyae, J. Andrade, G. Forbes, K. Fugilie, and G. Thiele. 2008. Farmer practices and adoption of improved potato varieties in Kenya and Uganda. In *Working paper 2008–5*. Lima, Peru: International Potato Center (CIP).

Kirumba, W., P. Kinyae, and M. Muchara. 2004. Irish potato market survey: Promotion of Private Sector Development in Agriculture (PSDA), GTZ/MOA.

Lusk, J.L., and D. Hudson. 2004. Willingness-to-pay estimates and their relevance to agribusiness decision making. *Review of Agricultural Economics* 26(2): 152–169.

Mabiso, A. 2005. Estimating consumers' willingness-to-pay for country-of-origin labels in fresh apples and tomatoes: A double-hurdle probit analysis of U.S. Data, University of Florida, Gainesville.

Martinez-Espineira, R. 2006. A box-cox double-hurdle model of wildlife valuation: The citizen's perspective. *Ecological Economics* 58(2006): 192–208.

Musengezi, J.D., F.J. Rossi, and S.L. Larkin. 2006. A double hurdle model of preferences for a proposed capacity reduction program in the Atlantic shark fishery. Paper read at Southern Agricultural Economics Association Annual meetings, February 5–8, 2006, at Orlando, Florida.

Rappoport, P., L.D. Taylor, and D.J. Kridel. 2002. Willingness to pay and the demand for broadband services. Paper read at Internatinal Communication Foresting Conference June, 25–28, at San Fransisco, USA.

Schulte-Gelderman, E., P. Gildemacher, and P. Struik. 2012. Improving seed health and seed performance by positive selection in three Kenyan potato varieties. *American Journal for Potato Research* 89: 429–437.

Thiele, G. 1998. Informal potato seed systems in the Andes: why are they important and what should we do with them? *World Development* 27(1): 83–99.

Tobin, J. 1958. Estimation of relationships for limited dependent variables. *Econometrica* 26(1): 24–36.

Tripp, R. 1995. Seed regulatory framework, resource- poor farmers: a literature review. In *Agricultural administration network paper 51*. ODI. London: UK.

Webb, E.J., D.T. Campbell, R.D. Schwartz, and L. Sechrest. 1966. *Unobtrusive measures: Nonreactive measures in the social sciences*. Chicago: Rand McNally.