Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Department of Economics

Willingness to pay for improved maize seeds among smallholder farmers

- A study of the input factor market in Kenya

Anna Lenksjö & Henrik Nordzell

Independent project · 15 hec · Basic level
Agricultural Programme – Economics and Management
Degree thesis 834 · ISSN 1401-4084
Uppsala 2014

Willingness to pay for improved maize seeds among smallholder farmers
- A study of the input factor market in Kenya

Betalningsvilja för förbättrat majsutsäde bland småskaliga bönder
- en studie av insatsfaktormarknaden i Kenya

Anna Lenksjö & Henrik Nordzell

Supervisor: Carl Johan Lagerkvist, Swedish University of Agricultural Sciences, Department of Economics

Assistant supervisor: Kristina Röing de Nowina, International Centre for Tropical Agriculture (CIAT-TSBF)

Examiner: Ing-Marie Gren, Swedish University of Agricultural Sciences, Department of Economics

Credits: 15 hec
Level: G2E
Course title: Independent project in Economics
Course code: EX0540
Programme/Education: Agricultural Programme – Economics and Management
Faculty: Faculty of Natural Resources and Agricultural Sciences

Place of publication: Uppsala
Year of publication: 2014
Cover picture: Anna Lenksjö
Name of Series: Degree project/SLU, Department of Economics
No: 834
ISSN 1401-4084
Online publication: http://stud.epsilon.slu.se

Key words: Economics, Willingness to pay (WTP), Factor market, Kenya, Embu, Bondo, Smallholder farming, Inputs, Soil fertility management, Improved maize seeds, OPV, Hybrids

SLU
Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences
Department of Economics

Acknowledgements

Our Minor Field Study in Kenya has been a fantastic experience which we will keep as a great memory for the rest of our lives. We are very thankful for this opportunity and the chance we got to see and learn new things. This work was in part made possible through funding from the Swedish Ministry of Foreign Affairs as part of its special allocation on global food security called UD40. The study would never have been possible without all the respondents who participated, nor without the support of Prof. Carl Johan Lagerkvist, Dr. Kristina Röing de Nowina, Livingstone Chibole and the help from our interpreters. We would also like to thank our friends and fellow students on this project that we are happy to have shared this adventure with. Our warmest thank you!

Abstract

Kenya is considered to be a developing country. This means that basic needs such as nutrition are not met for an extended period of time (www, Sida 1, 2012). Approximately half of the population is living under the poverty line (www, CIA 1, 2012). Agriculture is the largest sector in the country, employing 75% of the population. These are thereby directly dependent on the sufficiency of outputs received. This makes efficient, easy-accessible and cheap agricultural practices an important matter in order to improve food security. Maize is the prime staple food commodity in Kenya and represents a substantial share of people's nutritional intake. It exist a number of improved maize seeds on the market, that grow plants with a better pest resistance and provides a higher yield for the farmers.

This study is the result of questionnaire based interviews with 52 small scale Kenyan farmers. The study was located to two separated areas; Bondo in western Kenya, and Kibugu in central Kenya. The questionnaire captured the farmers' use and perceived importance of the use of soil-fertility enhancing practices and improved seeds. Willingness to pay for two types of improved maize seeds was measured through a payment card. It was required to use different seeds for the two areas due to diverse climate conditions.

Through the results a number of factors was determined that decides how farmer choose which practices to use. Those were familiarity, monetary cost, accessibility, time consumption and social acceptance. Practices that already were used to a large extent received high importance while expensive and time consuming practices received low importance. Farmers have constraints in their production which sometimes prevent them from using the practices wished for. These are mainly time, money and for Kibugu also the amount of land.

The Willingness to pay for the seeds was 98 Kenya Shillings per kilogram for Kibugu and 87 for Bondo. Both these amounts are significantly lower than the market price for improved seeds at the spring of 2012 (~175-200 KSH/kg). Farmers stated that the high price prevented them from purchasing as much seeds as wished. This indicates that the market price is too high. There are few actors on the seed market in these rural areas which enables the suppliers to exercise market power, in this case by setting a price above equilibrium. An increased competition would lead to price reductions and a higher consumption which could benefit the farmers and help secure food safety in Kenya.

A regression was made over the correlation between the willingness to pay for improved seeds and the use of other input factors. Farmers that already use other inputs such as animal manure, hired labor and chemical fertilizer should also have a demand for improved seeds according to Liebig's law of minimum and expansion path theory. The regression showed that income, the use of chemical fertilizer, animal manure and crop residues have a positive effect on willingness to pay, whilst hired labor have a negative effect.

Sammanfattning

Kenya anses vara ett utvecklingsland vilket innebär att grundläggande behov som ett tillräckligt näringsintag inte alltid uppfylls (www, 1 Sida 2012). Ungefär hälften av befolkningen lever under fattigdomsgränsen (www, CIA 1, 2012). Jordbruket är den största sektorn i landet och sysselsätter 75% av arbetskraften, vilka därmed är beroende av att produktionen genererar en tillräcklig avkastning för deras försörjning (www, Sida 1, 2012). Tillgängligheten av effektiva och billiga jordbruksmetoder är en viktig fråga. Majs är den viktigaste basgrödan i Kenya och står för en stor del av befolkningens näringsintag. Det finns ett antal förbättrade majsutsäden på marknaden som ger mer resistenta växter och en högre avkastning för bönderna.

Denna studie är ett resultat av enkätbaserade intervjuer med 52 småskaliga lantbrukare i Kenya. Studien var lokaliserad till två separata områden; Bondo i västra Kenya och Kibugu i centrala Kenya. Genom enkäten kartlades användningen av samt den upplevda vikten av olika metoder för att öka markbördigheten. Betalningsviljan (Willingness to pay) för förbättrade majsutsäden mättes med betalningskort (Payment Card). Två olika typer av förbättrade utsäden valdes då detta krävdes på grund av platsernas olika klimatförhållanden.

Genom resultaten urskiljdes ett antal faktorer som avgör lantbrukarens val av vilka metoder denne använder i sin produktion. Dessa var tradition, monetär kostnad, tillgänglighet, tidsåtgång och social acceptans. Metoder som redan användes i stor utsträckning hade stor betydelse, medan dyra och tidskrävande metoder fick låg prioritet. Jordbrukarna har begränsningar i sin produktion som ibland hindrar dem från att använda en önskad metod. Dessa är främst tid, pengar och i Kibugu även marktillgång.

Betalningsviljan för utsädena var 98 Kenyanska shilling per kilogram för Kibugu och 87 för Bondo. Båda dessa belopp är betydligt lägre än marknadspriset för förbättrat utsäde våren 2012(~ 175-200 KSH / kg). Lantbrukarna uttryckte att det höga priset hindrade dem från att köpa så mycket utsäde som de önskade. Detta indikerar att marknadspriset är för högt. Det är få aktörer på utsädesmarknaden i dessa rurala områden, vilket möjliggör för säljarna att utöva marknadsmakt. I detta fall sker det genom att priset sätts över jämviktspriset. Ökad konkurrens skulle leda till prisreduceringar och högre konsumtion vilket skulle gynna bönderna och hjälpa till att säkra mattillgången i Kenya.

En regression gjordes över korrelationen mellan betalningsviljan för förbättrat utsäde och användningen av andra insatsfaktorer. Lantbrukare som redan använder övriga insatsfaktorer såsom gödsel, inhyrd arbetskraft och handelsgödsel borde även ha en efterfrågan på förbättrat utsäde enligt Liebigs minimilag och expansionsvägs teori. Regressionen visade att inkomst, användningen av handelsgödsel, gödsel och plantrester har en positiv effekt på betalningsviljan, medans inhyrd arbetskraft har en negativ effekt.

Abbreviations

Acres	Area of land where 1 acre equals to approximately 0.40 hectare
Agriculture extension	Educational and informative agency organized by professionals
CIAT	International Centre for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Center
CVM	Contingent Valuation Method
GDP	Gross Domestic Product
Intercropping	To combine the production of two plants for beneficial purposes
KARI	Kenya Agricultural Research Institute
KSH	Kenyan Shilling, 100 KSH is equal to approximately 8.7 SEK
Mulching	To apply crops residues at the top of soil to keep moister in the soil
OPV-seed	Open Pollinated Variety seeds
Sida	Swedish International Development Cooperation Agency
SLU	Swedish University of Agricultural Sciences
Striga	A weed
Subsistence farming	Growing crops only for home consumption and not for sale
WTP	Willingness to Pay

Table of Contents

1 Introduction

Doing a minor field study (MFS) gave the authors of this paper the opportunity to see food production in a developing country and thereby gain a lot of new knowledge and hopefully understand the global food production system better. This will be useful in the future when working with international trade and especially trade with food commodities.

Kenya was a suitable ground for the field study as Dr Kristina Röing de Nowina works at the International Centre for Tropical Agriculture, CIAT, in Nairobi and has contacts that were useful. This together with the support provided by the organisation enabled a better project.

1.1 Problem background

Kenya gained independence from the United Kingdom in 1963 and has been in a development process since then. Especially the education level and the medical care have improved substantially (www, Sida 1, 2012). Even though Kenya is a growing economy, half of the population is still living beneath the poverty line (www, CIA 1, 2012). This means that the daily basic needs of shelter, clothing and nutrition are not met for an extended period of time. The country depends on support from developed countries (www, Sida 1, 2012). Kenya's Gross national product was the year of 2011 at a level of $ 1,800 per capita, to be compared with Sweden's $ 40,900. Only 61% of the population has access to pure drinking water and the expected living age is 59.48 years. In Sweden all of the population has access to pure drinking water and the expected living age is 81,07 years (www, CIA 2, 2012).

Food is an essential need for all people and with a rapidly growing world population food production needs to double until year 2050 (www, EU 1, 2012). Agriculture is still the largest sector in Kenya, employing three fourths of the population. A majority of the population live in rural areas (www, Sida 1, 2012). Desertification and soil erosion are two out of a number of environmental threats to Kenya and its agricultural development (www, Library of Congress 1, 2012). This needs to be dealt with together with a more efficient food production that can improve livelihoods and reduce mal-nutrition problems.

Efficient food production plays a key role in the development of the country (www, Sida 2, 2011). There is a high potential to increase agricultural output in Sub-Saharan Africa, but the developing countries can rarely afford to make the required investments themselves. Foreign investments, sometimes referred to as "Land-grabbing", can be a solution to a faster development in these areas (www, Sida 3, 2012). One fifth of the land in Kenya is being cultivated. Most common crops are tea, coffee, maize, wheat, sugarcane, fruits, vegetables, dairy products, meat and poultry (www, CIA 1, 2012). The main exported crops are coffee, tea and horticultural products. Income from the agricultural sector represents 22% of GDP (www, CIA 1, 2012). The most important food crop for subsistence farmers in the country is maize. Together with beans it makes what is now a national dish amongst Kenyans; Githeri. It is simple, nutritious and cheap. Some families eat it as a main meal every day in an otherwise often protein-poor diet.

The cultivation technology in Kenya is much differentiated from present technology used on large-scale farms in the western countries. One reason is that most farms are small-scale because of the fact that a large share, approximately three fourths, of the population still lives in rural areas (www, UNICEF 1, 2012). The own produced food commodities are essential for most of these persons to survive. Farmers growing for subsistence purposes are in majority and often have a lot less land then the national average of 4.8 acres (2 hectares) per household (www, CIA 1, 2012). Farms are generally low producing, caused by factors such as small plots, low mechanization and economic constraints. This would not have to be a problem if people were able to acquire income from other sources than farming and then had the possibility to buy the food they are unable to grow themselves. But the chances are small for farmers living in rural areas to get non-farm employments. Therefore an increase in production would enable farmers to produce a surplus which could generate more income and improve their economic situation.

Efficiency is needed to reach an increase in production, for example by implementing different modern techniques such as the use of fertilizers and improved seeds (personal communication, Röing de Nowina, 2011). It is also essential with a sustainable agricultural system where maintaining soil fertility is a key issue to enable farming for many generations to come. If the removal of essential nutrients from the soil is larger than the returns, soil fertility will decline with time and the costs for farming will grow. An increasing amount of inputs will be required to receive a sufficient harvest, where the costs will burden poor farmers the most.

1.2 Problem

High yielding maize seeds are one method to receive a higher output. The Kenyan seed industry is structured into a formal and an informal system. In the informal system farmers use retained seeds from their own or a neighbour's production, and there is also a possibility to buy local varieties. In the formal system farmers purchase certified hybrids and Open Pollinated Variety seeds, OPVs from suppliers. The local variety seed is yellow or white maize which has been used by farmers in a specific area during a long time. The seed have become adjusted to the altitude, amount of rain, pests etcetera in the specific region. It can be retained for as many seasons as desired. Its most significant benefit is that it matures early, after about 2-3 months. In eastern Africa it yields about 0.54 tons per acre, or approximately 1.3 tons per hectare (www, FAO 1, 2012).

A hybrid seed is the first generation offspring from crossing two highly inbred parents. They come out stronger than their parents thanks to the phenomenon "hybrid vigour". They are developed to be high yielding and can deliver above 1.8 tons per acre (~4.3 tons/hectare). Although the seeds require fertilizers, pesticides and lots of water to give a high output and the improved yield capacity comes at the expense of strength and resistance toward pests and environmental conditions. Furthermore the mature time is in general long, between five and six months (www, Primal Seeds 1, 2012). But with a well managed soil and the use of correct inputs the seed has a high potential.

An OPV seed is an improved seed developed from local varieties to be drought tolerant, disease resistant and well adapted to the areas for which they are recommended. They are supposed to be as good as any hybrid and can be retained, which is a big advantage for the farmer (www, Gaia Movement Trust 1, 2012). Today the use of improved seeds is limited (Seward and Anderson, 2003). In 2006 83% of the households made formal seed purchases. These formal seeds stood for 18% of the total use of seeds, which implies that the purchases was of small quantities. Because of the high price of certified seeds, the less efficient retained seeds are still the most frequently used method and in 2006 it was 63 % (Ayieko & Tschirley, 2006).

A problem is that not many revenue driven seed companies wants to stock this OPV seed (www, Primal Seeds 1, 2012). The hybrids guarantee a more frequent income for the seed companies and are therefore more interesting for them to promote. The hybrids can be fertile, but if retained they revert back over 4-5 generations to variations of the low yielding parental types. That is why farmers often don't save seed from the hybrids for further generations but go back to the seed distributor to purchase more of the first generation hybrid seed (personal communication, Paul Keese, 2012). Although it is possible to insert a genetic terminator into the hybrids' DNA ,which is intentionally done by seed companies in order to make them sterile and so force farmers to purchase new seeds every season (www, Primal Seeds 1, 2012), all this to earn more money. Food security is a big problem in Kenya and when addressing these questions maximum profits should not be the main target.

1.3 Aim and delimitations

The aim of this study is to gain a general understanding of agriculture in low income countries and the economic situation in small-scale farming systems in Kenya. The main objective is to investigate farmers' WTP for improved seeds and compare it to the present market price. The study also investigates how the use of different inputs affects the WTP. Specific objectives are to survey;

- *What is the Willingness to pay for improved seeds among smallholder farmers in central and western Kenya?*

- *How do small-scale farmers in Kenya perceive different methods to improve soil fertility, and how does this affect the WTP?*

The first specific objective will be determined with a payment-card and compared to theory about factor markets. The second will be analysed with data from a questionnaire about soil fertility practises and determined with a regression and theories about factor demand and cost minimization.

The statements in the survey referred to what practices that were used during the last growing season, the short rain season of 2011, and thereby limited our research to this period. This research will be geographically limited to Embu district in the Eastern Province and Bondo district in the Nyanza Province in the western part of Kenya. The specific areas was selected because Röing de Nowina has other projects going on there and this study can therefore be used as a complement and/or in addition to the information retrieved from those. Then locations were picked according to the type of farming that is used there, number of sub-locations and the level of English spoken in the area. The areas are quite homogeneous within themselves. The farmers have similar conditions for producing and economically. In Kenya knowledge and farming culture is passed down through generations. Hence the answers are expected not to differ widely, which motivates a smaller sample size. This study is limited to 30 interviews in Embu and 30 in Bondo district.

The two locations have very different conditions for maize production; therefore the Willingness to Pay (WTP) study had to differ between them. The choice of reference seeds were limited to seeds that are recommended in the respective areas. The one used in Embu is developed by Kenya Seed and adapted to medium altitude areas of East Africa and resistant to foliar diseases and pests, which makes it a satisfying reference for market price of improved seeds. In Bondo the reference seed is developed by CIMMYT, a governmental agency. It is an OPV-seed that has been bred from local varieties of Western Kenya which make it suitable.

2 A theoretical perspective

This chapter provide the theoretical background on production theory, profit maximization, factor markets and willingness to pay for the empirical study undertaken in this study.

2.1 Production

Just as a consumer make purchasing decisions according to preferences, budget constraints and combinations of goods to maximize their satisfaction a firm determines their production according to available technology, cost constraints and different combinations of inputs to produce outputs. Inputs, or factors of production, include everything that the firm uses to produce outputs, or products. Inputs can be grouped into three broad categories, labor, materials and capital. Labor includes hired workers, both skilled and unskilled. Materials include goods and raw material that the firm buys and transforms into finalized products. All the buildings, land, machinery and other equipment that is used in the production belong to the last group, capital (Pindyck & Rubinfeld, 2009).

Depending on how the firm uses combinations of these inputs they can produce a variety of outputs. This is described with a production function which is normally simplified as;

$$q = f(K, L, M) \qquad (1)$$

where q is the level of output and K and L the level of capital and labor used, respectively, and M the level of materials. The production function applies to a certain available technology and the firm is presumed to work efficiently (Pindyck & Rubinfeld, 2009). For subsistence farmers the most important inputs are capital, especially land and equipment, and materials such as seeds, irrigation water and fertilizers. Hiring workers are uncommon do to cost constraints. Instead the cost of labor for the farmers can be seen as the opportunity cost of not working for a wage (El-Osta & Ahearn, 1996). Therefore this paper will focus on capital and materials.

Inputs can be variable or fixed, which means that the firm can't substitute the inputs from one category to another. In the short run only labor is variable while in the long run all inputs are said to be variable. What is considered long run changes between industries and level of technology (Pindyck & Rubinfeld, 2009). For the subsistence farmer who has a very low level of technology it doesn't take long to vary any of the materials or equipment being used. Therefore the long run scenario where all inputs are variable is of most interest.

However if a farmer only wants to change the amount of seeds that is used it is useful to know how much more output that can be produced from an additional unit of seeds. This is called the marginal product (MP) of inputs.

$$MP_M = \frac{\partial q}{\partial M} = \frac{\partial f(M.K)}{\partial M} \qquad (2)$$

Normally the marginal product increases rapidly in the beginning, the first additional seeds give a lot more output, making the total product increase exponential. The MP

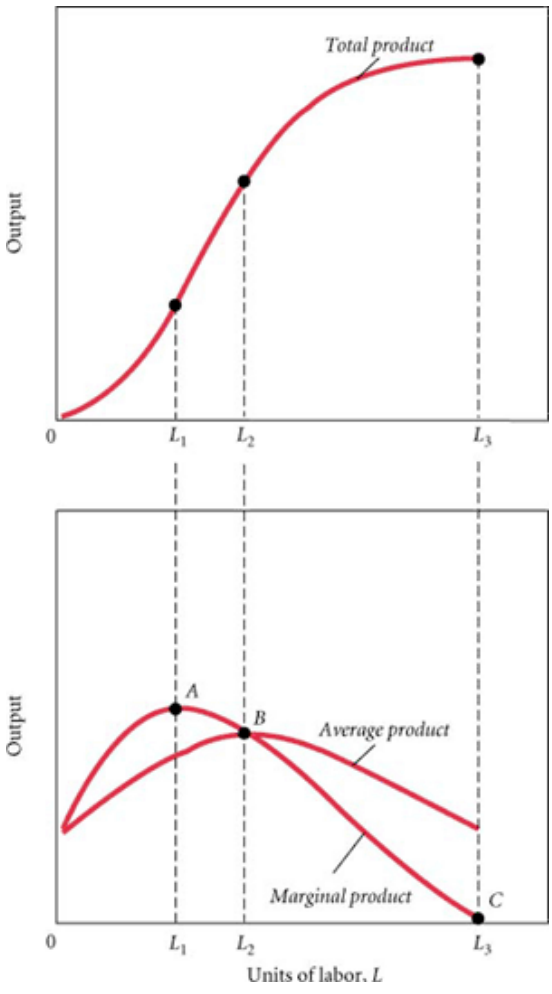


Figure 1. Total and marginal product of inputs

then declines which make total product increase in a diminishing pace until it reaches maximum output. After that the marginal product is negative and any extra seeds will lower the amount of output, this might be because there is not enough nutrition in the soil or water for irrigation so the seeds have to compete, see figure 1 above.

2.1.1 Profit maximization

To reach maximum profit the farmer needs to find the level of output where the marginal cost (MC), the cost of using an extra unit of seeds, is equal to marginal revenue (MR). This point is located somewhere below the maximum output which means that producing as much as you can isn't always the most profitable choice (Pindyck & Rubinfeld, 2009). The extra units of output that one unit of input contributes to (MP) times the marginal revenue (MR) from the last unit of output give the additional revenue from that last unit of input. This is called the marginal revenue product (MRP) and is the firm's factor demand curve when only one input is altered. The firm will buy the amount of materials where this curve intersects with the cost of the materials, n. A competitive firm faces an infinitely elastic demand for its outputs at the market price p which is its marginal revenue. In this case the price of corn on a local market. Knowing that the marginal cost equals the input cost divided by the marginal product this is also the point where marginal revenue is equal to marginal cost and profit maximization is achieved (Gravelle & Rees, 1992);

$$MRP = MP * MR = n \Rightarrow MR = \frac{n}{MP} \; and \; MC = \frac{n}{MP} \Rightarrow MR = MC = p \quad (3)$$

So the firm's decision of how much to use of materials depends on the price of the factor and the price of the final product.

If all inputs vary the production decision is a bit different. If for example the price of materials falls the farmer adjusts both materials and capital. The firm's goal is then to maximize its profit by choosing the correct combination of these inputs. Since the firm's profit function is its revenue function minus costs a profit maximization equation can be written as (Perloff, 2011);

$$max\, \pi \; = \; R\,(q(M,K)) \; - \; nM - rK \qquad (4)$$

where π is profit, R is revenue, n is the cost of materials and r is the cost of capital. The firm's first order condition for profit maximization show that they set their marginal revenue product of each input equal to the cost of that input, e.g.;

$$\frac{\partial \pi}{\partial M} = \frac{\partial R}{\partial q} * \frac{\partial q}{\partial M} - n = 0 \Rightarrow MR * MP_M = MRP_M = \frac{\partial R}{\partial q} * \frac{\partial q}{\partial M} = n \qquad (5)$$

This means that a firm will buy materials up to the point where the marginal revenue times the marginal product equals n, which is the firm's long-run factor demand equation (Perloff, 2011).

2.1.2 Cost minimization and output maximization

A firm's or a farmer's objective might be to minimize its costs to produce a wanted output or to produce as much output that is possible given a cost constraint. The answer to these questions can be dealt with in the same way. Again the problem is to choose the right combination of inputs. The amount of inputs that will be used depends on the prices of the inputs. All possible combinations of two inputs that can be purchased for a given cost can be described with an isocost line. Written as an equation for a straight line the isocost line looks like this (Pindyck & Rubinfeld, 2009);

$$K = \frac{C}{r} - \frac{n}{r} * M \qquad (6)$$

where C is the total cost. The maximum output that can be produced with each combination of inputs is shown with an isoquant$q$. So if the farmer wants to produce the amount of corn he needs to feed his family he wants to choose the point on that isoquant, or output level, that minimizes total cost. This is achieved by finding a combination of inputs that touches the isoquant and has the lowest cost of all possible combinations, point E in figure 2 (right). The farmer could also produce the same amount of output at point S but at a higher cost. If a farmer instead wants to produce as much as possible given a fixed cost, he should do so where the isocost line is tangent to the highest isoquant, point E in figure 2 (left) (Pindyck & Rubinfeld, 2009).

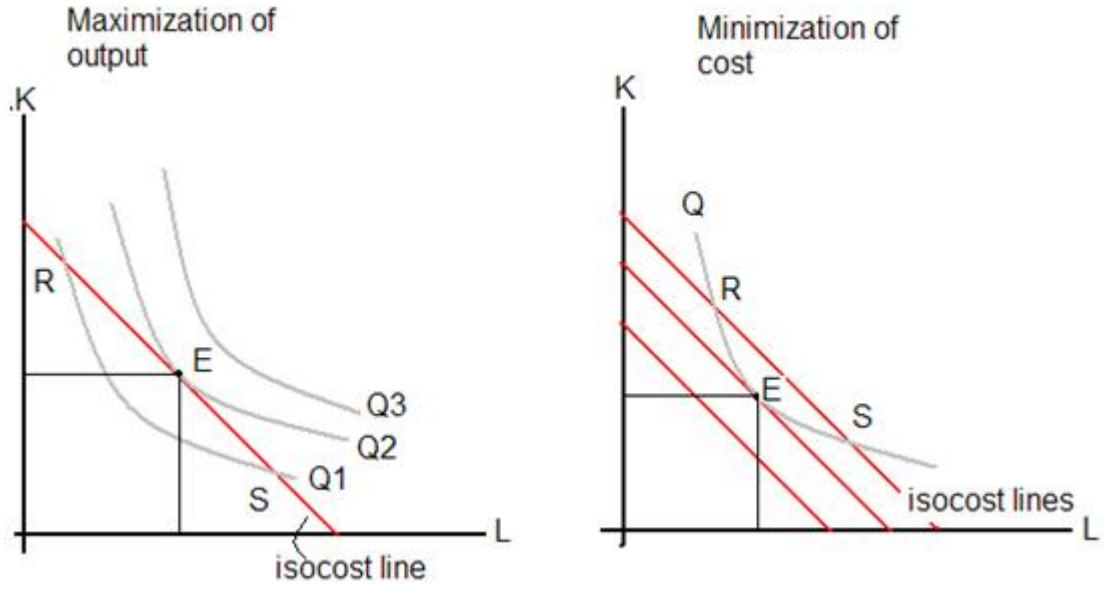


Figure 2. Optimal choice of input combinations

The slope of the isoquant is the marginal rate of substitution ($MRTS$) and the slope of the isocost is found in the equation of the straight line, $-n/r$. At the point of tangency these two slopes are equal. The $MRTS$ also equals the negative ratio of the marginal product of the inputs.

$$-\frac{MP_M}{MP_K} = -\frac{n}{r} \Rightarrow \frac{MP_M}{n} = \frac{MP_K}{r} \qquad (7)$$

A cost minimizing firm should therefore buy inputs until the last unit of money spent on one input gives as much extra output as the last unit of money spent on another input. The equation for choosing level of inputs in the output maximization problem looks the same (Perloff, 2011). Which of these two approaches of production to choose depends on the objective of the farmer and how much money that can be spent on the production. Is it a question of producing enough to feed the family and save money or to produce as much as possible to be able to sell some and earn money. The level of inputs that solves the cost minimization problem is titled the conditional factor demand and is thus a function of factor price and output level (Gravelle and Rees, 1992).

$$xi^* = xi^*(p_{x1}, \dots, p_{xn}, y) = x^*(p_x, y) \qquad (8)$$

Since factor demand is conditional of output an explanation to the choice of output level needs to be included in the production model. A company's cost function relates the minimized factor costs and output (Gravelle and Rees, 1992).

$$C = \sum p_{xi} * xi^* = p * x^*(p_x, y) = C(p_x, y) = LTC \qquad (9)$$

The cost function has these general properties:

- Increasing with y, when output increases the cost increases as well and non-declining with px, if p'x ≥ px then C (p'x, y) ≥ C(px, y)
- Linear homogeneous for px; C (tpx, y) = tC (px, y)
- The cost function is continuous and concave for px, when the price changes, the firm will react with respect to its use of the input. The minimized cost for the production of a given level of output is a function that increases in px but at a decreasing rate.
- Shepard's lemma: the conditional factor demand for a given input factor, *x*, is obtained as the marginal change in the cost function for a marginal change in the price of the input factor, px.

Expansion path
For each given level of output there is a cost minimizing combination of inputs. By drawing a line from origin through all the tangency points a line is created that is called the expansion path. This shows the long run cost effective way to expand the production when the budget increases (Perloff, 2011).

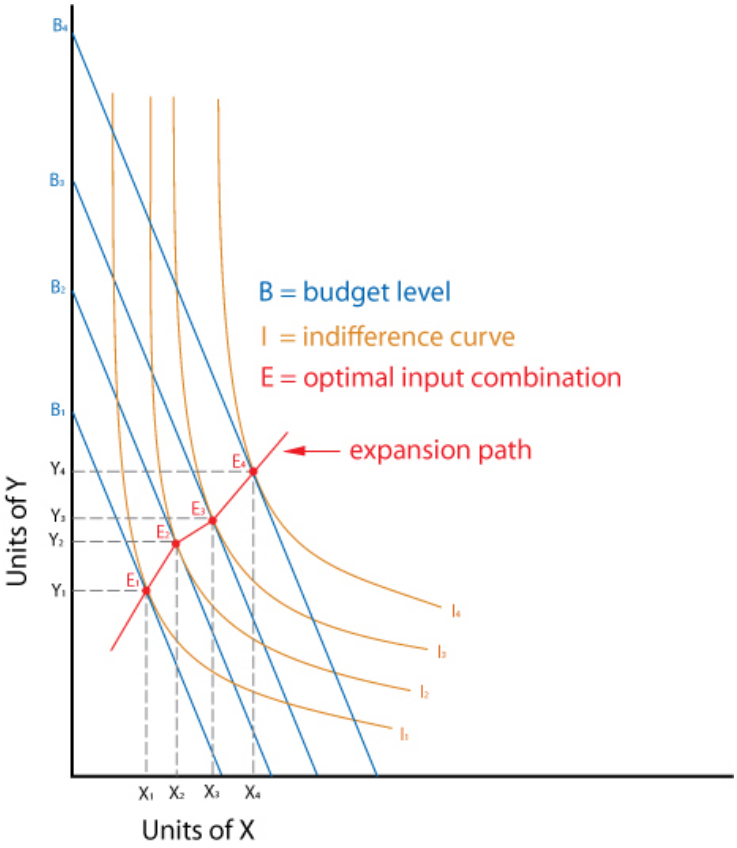


Figure 3. Expansion path of inputs Y and X

2.1.3 Factor markets

Most inputs are bought on factor markets. The price and quantity on a perfectly competitive input market is found in the equilibrium where the supply and demand curves intersect. The factor supply curve is the firm's average expenditure (AE) curve. The demand curve is as mentioned before the firm's marginal revenue product, $MRP = MR * MP$ (Perloff, 2011). The buyers and sellers on these markets can also however be e.g oligopolistic or monopolistic. This affects the quantity and the price of the inputs that is bought. Factor demand curves vary with the firm's market power on its

output market. The marginal revenue is a function of not only the price but also the elasticity of demand facing the firm on the output market and the input demand curve for a monopoly firm looks like:

$$MRP = p\left(1 + \frac{1}{\varepsilon}\right) * MP \qquad (10)$$

If there is a number of identical firms each of them face an elasticity of demand of $n\varepsilon$ on the output market. Since the elasticity is negative firms with market power on their output market will have an input demand curve that lies below the competitive one, and a lower quantity of inputs will be bought at any given price (Perloff, 2011).

When a seller on the input market exercises market power they affect the price met by the firm. To maximize profit the seller set the price at nm where the quantity demanded is qm, see figure 4. This quantity corresponds with the point where the market supply curve and the marginal revenue of the firm intersect (Pindyck & Rubinfeld, 2009).

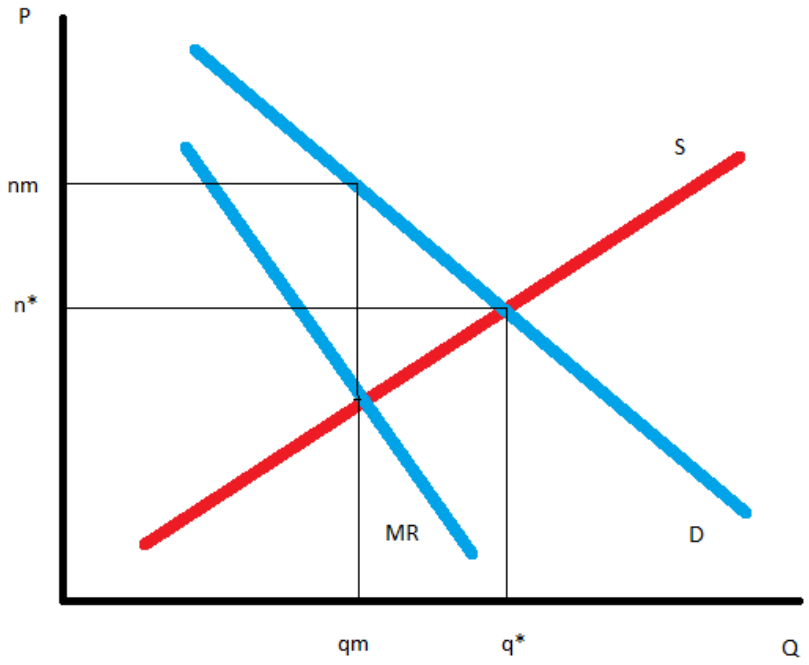


Figure 4. Price of inputs on a factor market with a monopoly seller

The price of the input determines the firm's average expenditure, i.e. the supply curve met by the single firm (Pindyck & Rubinfeld, 2009). Since the price set by the monopolist is higher than the perfect market price, n*, the firm's average expenditure will be higher. So when a seller exercises market power on a factor market the price of inputs will be higher and a smaller quantity will be bought, see figure 5.

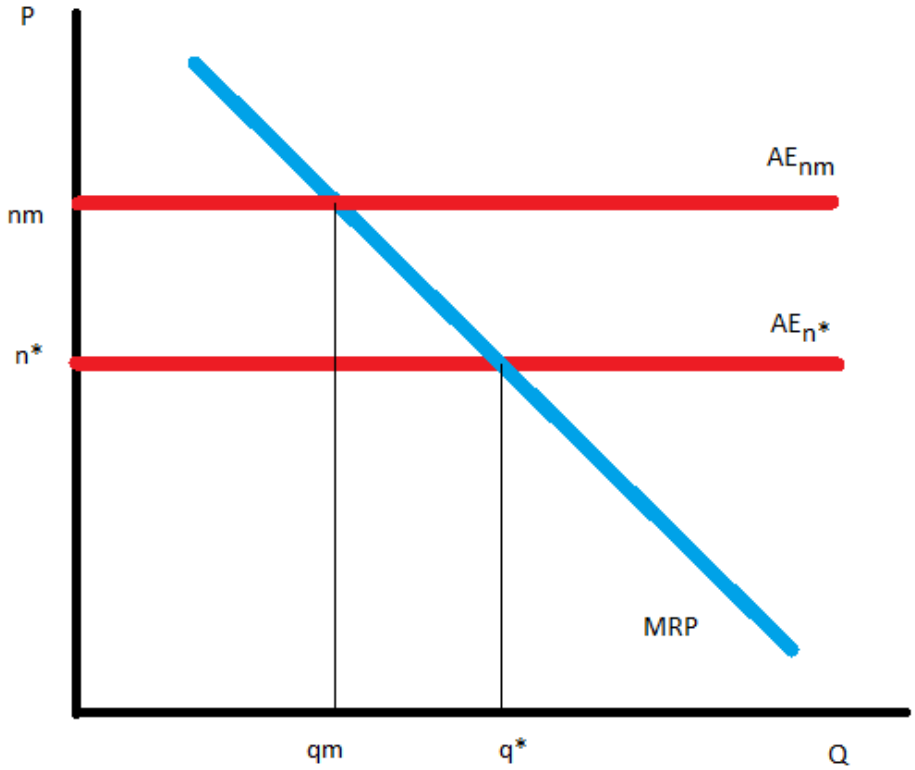


Figure 5. Difference in price and quantity of inputs for a single firm, perfect market versus monopoly seller

2.2 Willingness to pay

Willingness to pay (WTP) estimates the maximum amount a person is willing to pay in order to obtain a certain good or condition. The theoretical basis of WTP is equivalent to the *Compensating Variation* (CV) measure. The CV is a measure of how much a consumers' income needs to increase or decrease in order to keep utility constant in the case of a price change of goods, a change in product quality or if new products are introduced (University of Madrid, Consumer theory, 2012). This can also be interpreted so that the utility received from a purchase should be equal to the utility given up in money, and thereby keep the utility level constant. The respondents´ stated utility is based on his/hers preferences and can therefore be expected to differ between individuals.

Studies on WTP can give an estimation of the firms' marginal revenue products, i.e. the demand for an input. The result will expose differences between an input's market price and the buyers' stated value of the input. A market price that is significantly higher than the stated WTP value could indicate that the economic rent is larger than the buyers' surplus, which means that the sellers have market power. Firms will only purchase an input if the market price is equal or lower than their willingness to pay. A market price that is too high will lead to fewer buyers. If the supply curve is located entirely above the demand curve these will not intersect at any point. This will therefore result in a non existing market for the input (Gravelle & Rees, 1992). On the other hand, if the stated WTP is higher than the market price there might be revenues to earn for the seller. Given a normal good consumption increase correlates with price decreases (www, Ecosystemvaluation 1, 2012).

Contingent valuation method

Contingent Valuation method (CVM) is used to estimate economic values of goods and services. This economic value, the willingness to pay (WTP), can either be stated directly by the individual or revealed through actions. The Contingent Valuation method is a direct method, since respondents are directly asked to state their WTP. It is therefore also known as a "stated preference" method. This method is based on hypothetical scenarios, in contrast with the "revealed preference" method where the WTP-value is based on observation of the individuals' actions (www, Ecosystemvaluation 1, 2012). A risk when using hypothetical methods like this one is that the respondents state a higher value than their true WTP. Familiarity with the presented situations can counteract this bias, especially in cases concerning market-goods (Lagerkvist et al, 2011). It is therefore important to address the issue to ensure a high credibility of the study. A so called Payment card (PC) can be used for measuring WTP with the Contingent Valuation method. Professor Carl-Johan Lagerkvist used a Payment Card in the study "Consumers' Willingness to Pay for Food Safety in Nairobi: The Case of Fresh Vegetables", which was conducted in Kenya. This method to measure WTP is well established compared to other methods. Two situations are presented in the Payment Card; the initial situation (A), and the improved situation (B). It is presumed that a main part of the respondents are currently in situation A. The interviewees are supposed to state in the maximum price they are prepared to pay to get to situation B. Through the study the respondents are doing a trade off between the utility received through the purchase of the specified product and the corresponding loss of money. Thereby a concrete price is received, which then can be compared with the current market price.

Questionnaires are preferably personally carried out, since this result in a higher answer frequency with a better quality. Personal contact can also minimize problems with the interpretation of questions since the interviewers have a chance to ensure that respondents understand it properly. This technique also enables so called cheap talk, which means that the interviewer have a chance to stress and ensure that the stated WTP is as close to the truth as possible (Brännlund, R., Kriström B., 1998).

3 Method

In this chapter the overall structure of the study is described. In the first section it is described how the economic theory has been applied to the study, thereafter how information has been gathered and how the interviews has been conducted. The second last section describes the questionnaire used for the study, and the last section discusses potential sources of error.

3.1 Conceptual framework

The theoretical basis of the study has been about production theory and willingness to pay and will be used to analyse the results and thereby give answers to the specific objectives.

The WTP will be estimated with the payment-card. The average value will be seen as an estimation of the price that farmers are able to pay on a regular basis for a desired amount of improved seeds. When the estimated WTP is received it can be used to analyse the market with theory about factor markets. The WTP is an estimation of the firm's demand and compared to the present market price it gives information about the market situation. According to theory less of an input is sold if any actor on the input market exercises market power and thereby raising the price. If the average WTP-value is lower than the market price it might indicate that the factor market for improved seeds in the area is not in perfect competition. Thereby farmers will buy less improved seeds than what would be the case if it was.

The farmers approached in this study have a small budget and limited resources why theories about cost minimization and output maximization are more applicable than profit maximization theories. The farmers can try to minimize cost to produce the level of output that is needed for the household. The most basic scenario and the most probable is that the farmers have a certain amount of money that they can spend on the farm and with that produce the highest level of output possible. According to the expansion path theory there is an optimal cost minimizing combination of inputs for each level of output. With the same reasoning as with Liebig's Law of the Minimum, you would expect all inputs to be at a high level to obtain the highest possible output. This means that a farmer that uses inputs to a high extent should have a higher WTP for improved seeds, since the utility of using more and better seeds in combination with other inputs is higher. To research this question the second part of the questionnaire called soil fertility was used.

According to the studied theory the expected results is that the farmers are trying to maximize output (yield) given their limited resources, such as capital and labor. An example of this strives for effectiveness is to prioritize the methods that they are stating as important in the questionnaire. This theory also implies that farmers that already use yield-enhancing methods to a higher extent (such as mulching and using fertilizers) would have incentives to state a higher WTP for the improved seed compared to farmers that use those methods to a lower extent. This is analyzed with a general multiple regression model of the form:

$$y_i = \beta_1 x_{i1} + \beta_2 x_{i2} + \cdots + \beta_p x_{ip} + \varepsilon_i,$$

The part of the questionnaire where the respondents rated the importance of different soil fertility enhancing practices was used to establish which practices that were perceived as most important. It was thereafter possible to point out whether these practices were being used by the farmers from part 3.2 in the questionnaire. These yes or no answers were then converted into dummies and used in the regression together with income, land etc with WTP as the dependent variable. It was expected that there would be a positive correlation between inputs and WTP, and thereby result in a positive coefficient. Income is expected to affect WTP positively while income^2 is expected to have a negative affect due to lower income at the end of a person's lifetime.

3.2 Interviews

This study is based on information gathered through interviews with small-scale farmers, located in two separated geographical areas in Kenya, which were described further in section 3.2.1 below. After discussion with our supervisors we came to the decision that approximately 50-60 interviews would be a sufficient amount to ensure a satisfying and credible result. These interviews were to be evenly allocated between the locations and their sub-locations.

The interviews were led by the authors of this study, together with different interpreters. Very few of the interviews could be conducted without the help of an interpreter. The roles of interviewer respective annotator were alternated for every second farmer. This was important in keeping focus and to participate in every process of the work.

Every interview had an approximate time requirement of between 40 minutes and 1.5 hours. The setup was as follows; at arrival we introduce ourselves and our study, before asking if the farmer is willing to participate. If the response is positive we start the interview with a short tour around the farm site to get a general picture of it and to make a farm sketch. Then we start off the interview with the first 2 parts.

Before the last two parts it is suitable with a short break with refreshments. The purpose is to gain new energy prior to the last two parts, so that the quality of answers will remain as constant as possible. When the interview is completed we thank the respondent and give him/her the opportunity to ask us something in return.

A test-run of the questionnaire was scheduled before leaving for the first intended interview-location. It was localized to an area fairly close to Nairobi and consisted of one interview per group. The purpose was both to test the actual questionnaire but mainly to prepare ourselves. Through this procedure weaknesses and strengths could be discovered. It was very helpful to know where problems might occur while interviewing.

3.2.1. Locations

Locations were selected after an evaluation of their availability, the type of farming that was used there, number of sub-locations and the level of English spoken in the area. The fact that CIAT and especially Dr. Röing de Nowina had on-going activities in the chosen locations was also an important fact. This way better support could be received and the information gathered could benefit other projects. Sub-locations were chosen after consulting our local contact persons. However, the borders between different sub-locations were sometimes a bit unclear, which resulted in that a few more sub-locations were used than first intended.

Figure 6. Map showing Kenya's provinces. Embu and Kisumu are marked out with green circles

The study took place in two areas in Kenya, Embu district and Bondo district. The two areas have significant geographical and climate differences which affects the agricultural activities on the sights. Embu is located in the centre of the country, slightly north of Nairobi and close to Mount Kenya (see map in figure 4 above). Thereby it indicates that the area is mountainous. Embu town is located at 1350 metres above sea level (masl) and the research area Kibugu is settled a bit higher up, by the foot of Mt Kenya. The average yearly temperature is just less than 18 degrees Celsius (www, Yr 2, 2012). Embu has 90 days of rainfall and about 1500 mm of rain in total per year (Ouma et al., 2002). Bondo is located in the far west close to Lake Victoria. The landscape is relatively flat and the climate is tropical - humid and warm even though it is located at medium altitude 1131 meters above sea level. The average yearly temperature is just above 18 degrees Celsius and average amount of rainfall is 1 456 mm. The number of days with over one mm is 137 (www, Yr 1, 2012). This means that rains are more intense in Embu compared to Bondo. A description of the two areas can also be found in table 1 below.

Table 1. A comparison between the two geographical areas in the study

	Embu (Kibugu)	**Bondo**
Location	Central Kenya	Western Kenya
Altitude	1350 m.a.s.l. (~1500)	1131 m.a.s.l.
Climate	Tempered – dry and cold	Tropical -warm & humid
Average temperature	18 °C	18 °C
Rainfall/year	1500 mm	1456 mm
Days with rainfall (yearly)	90	137

Since the agricultural conditions in the two districts Embu and Bondo are much differentiated we had to use two separate payment-cards with an improved seed that were recommended for the corresponding area (see Appendix 2&3). By asking employees at the International Center for Tropical Agriculture (CIAT), Kenyan students and searching the internet for articles we were able to determine these differences and which would then be a suitable seed to look at in each area. These seeds needed to be accessible on markets in each area so that we could have the market price as a reference for the study. The seeds chosen were the hybrid seed H513 for Embu and for Bondo an OPV seed called KSTP94. The hybrid is developed by Kenya Seeds, a commercial company, and the OPV by KARI, a governmental institute which aims to improve the situation for farmers. Their characteristics concerning yield, mature time and other important qualities were used to describe them in the payment card.

3.2.2. Sample size and randomization

A total number of 52 interviews were carried out, 26 in Bondo district and 26 in Kibugu. This amount was slightly lower than expected due to factors such as illness, although still in the aimed interval of 50-60 interviews. These were allocated over 4 sub locations in Bondo and 9 sub locations in Kibugu. One interview in each location was later determined to be invalid. One interview in Kibugu had to be cut short since the farmer needed to work. This interview was supposed to be finished through e-mail correspondence, but the answers were not received. In Bondo we found out that one of our farmers had already been interviewed by our fellow students, so there was no purpose with asking the same questions again.

The sub locations in Kibugu have a circular shape which enabled us to easily randomize the sample of respondents. They were selected by making a cross centred in the sub locations' middle with the ends on a distance of at least 500 metres in every direction. The aim was to interview five farmers in each sub-location, one in each direction and one in the middle, see figure 7. When 500 meters had been walked a farmer was asked if he or she wanted to participate in the study. If the response was positive that farmer was chosen, otherwise the next household was asked. In Bondo the process was simply to walk a distance of at least 500 m alongside the road to find the next interviewee, since their sub-locations are considerably larger and rectangular shaped.

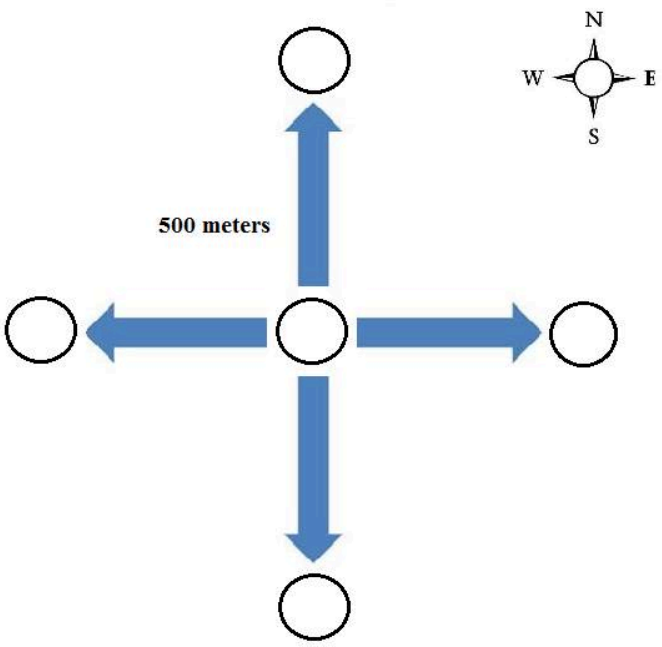


Figure 7. Schedule over the order of selected interviewees in Kibugu

3.2.3. Feedback

After the interviews the answers were registered. When all interviews were done in one district the answers were summarized and reviewed to gather preliminary results. Then the farmers were asked to meet up for a short feedback-session. They were given the summary in English and a translated version in Swahili (see Appendix 4). We had the opportunity to clarify any issues we had incurred during the initial interview and review of our data, and the farmers also got the chance to ask complementary questions. The farmers received a photograph which we had taken with the respondent during the interview. Most of the questions concerned soil fertility issues and could thereby not be answered by us in a reliable way. The farmers were informed that all the collected information is going to add up to an informative "farmers-day" later in the fall, which is hosted by CIAT.

3.3 Questionnaire

The questionnaire used for the study consists of four parts (see Appendix 1), and below follows a brief structural explanation of those;

Part 1. General information

Concerns basic information about the respondent and his/her household. Examples are size of farm, which types of livestock, and crops that are kept and income sources. The purpose of this part is to map out the structure of households in the area, which is of importance to be able to compare and make connections to the respondents' answers in the following parts.

Part 2. Soil fertility management

Contains different statements concerning soil fertility and is divided into three sections;

> **2.1** A table where the current and historical use of soil fertility improving techniques is ticked such as: "Have you ever used X to improve soil fertility?" (Yes/No)" and "Did you use this technique during the last season?" (Yes/No).
>
> **2.2** 34 statements to which the respondent answers Yes or No, such as "I collect animal manure from my neighbours".
>
> **2.3** Contains 31 statements similar to the ones in the previous part, but the respondents are now intended to rank these on a scale from 1 to 5, where 1 is "strongly disagree" and 5 is "strongly agree".

Part 3. Risk-benefit statements

The third part is mainly concentrating on the attitude towards using improved maize seeds. Ten differentiated techniques are listed, such as "Use of hybrid seeds alone", "Leave the farm to fallow", "Use of local variety seeds alone" and combinations of different seed types. This part is divided in two, where the respondent is initially asked about his/hers expected benefits of using each technique in the aspect of increasing crop yield, and thereafter the expected risks of not using them, i.e. decreasing crop yield. The answers are on a six-graded scale from 0-5 where 0 is "Cannot answer because I am not familiar with this technique", 1 is "To a very less extent" and 5 "To a very large extent".

Part 4. Willingness to Pay

This part consists of a payment-card that aims to identify the respondent's willingness-to-pay for an improved maize seed that is currently being sold on the Kenyan seed market. The Payment card will be carried out in person and will be based on relevant economic figures as well as the cultural environment to ensure that it is credible. The payment card contains a short description with text and illustrative photos of the improved seed that was used for the study. It is also a price ladder from 0 Kenya Shillings (KSH) per kilogram up to an amount of 200 KSH/kg. These are divided in intervals of 10 KSH each, where the WTP can be ticked. It is also possible to state answers above 200 KSH.

3.3.1 Revision

The initial idea of the use of the questionnaire has been revised to fit new theories and hypothesis. From the first part only a few questions is of importance. The third part has completely been excluded from this paper. The statements in the second part have been used to draw conclusions about input usage. The fourth part with the payment card has been used to establish the estimated willingness to pay value which then has been compared to the current market price.

3.4 Sources of error

There is a risk for sources of error in all types of studies, which might affect the results received. When conducting interview-based studies the use of an interpreter increases the risk. Working with an interpreter give the answers a grade of insecurity since the situation is not fully controlled. This insecurity can be limited by going through the questionnaire thoroughly with the interpreter prior to the interviews to avoid misunderstandings. It is important that the interpreter is aware of the purpose of the questions. Precautions were taken before starting the interviews so that insecurity could be limited as far as possible.

Some of the questions were experienced as sensitive or uncomfortable by the farmers. The most sensitive areas concerned income and willingness to pay. Farmers might have stated a higher income or WTP to seem wealthier than they actually are. In the counterpart there is also a risk that farmers state a lower income or WTP in hope that the research will lead to a price change that will affect them positively. Asking uncomfortable questions might also influence the respondent's attitude towards the study in general.

In part 2.3 the respondents grade their answers from 1-5. These statements build on the first part where the answers are "yes" or "no". This means that if the respondent answer "no" to a question in the first part, a few of the statements in the second part becomes hypothetical. In those cases it was difficult to determine if the answer should be 1 (strongly disagree – it is not important at all since he/she does not use these practices) or 3 (neither disagree nor agree – since he/she has no opinion in the matter). Depending on the particular situation either one of these has appeared to be the "correct" alternative. This has impacted the results when grading the most and least important practices. The results could have been more reliable if one alternative had been "I do not know". This would have made it possible to exclude answers from respondents who could not answer the question in mind.

Problems also emerged when the respondent did not understand a question. This resulted in situations when the interview had to move on without a sufficient answer. A few of the statements is the study are leading, so that a specific answer might be perceived as "right". Thereby the probability of receiving that specific answer is higher. It was difficult to receive graded answers in the second statement-part. Generally the answers remained unchanged from the first part, "yes" then meaning "important" in the context. This resulted in the need to complement by asking "just

important or very important?" in order to get a graded answer. A majority then answered "very important" since it was perceived as the correct or expected answer. These problems were more abundant in the interviews that were partly or mostly held in English. When a respondent did not appear to understand the question properly he/she gave the impression of wanting to hide it, and gave the answer that seemed to be the correct one.

Occasionally there was a need to divide longer statements into more than one part, in order to facilitate for the interpreter and farmer. This type of changes in the questions does not show in the results but should be considered when drawing conclusions from this research.

A significant amount of information has been received "outside" the questionnaire. This has been obtained by conversation, complementary questions and visual impressions. Information mentioned in the study that is not connected directly to the questionnaire has been received this way.

4 Results

Here the results from the interviews are put together. Some of the information has been received trough complementary questions. First the results for Embu will be presented and thereafter follows a section describing the results of Bondo.

4.1 Embu

The typical farmers in Kibugu, Embu have a house for living, a small house for cooking and stables for animals. Coffee, and tea is grown as cash crops. Maize and beans are cultivated for home consumption and often intercropped in the fields. Bananas and avocados are other crops that are often grown. A simplified picture of a typical farm in Embu is showed in figure 8 below.

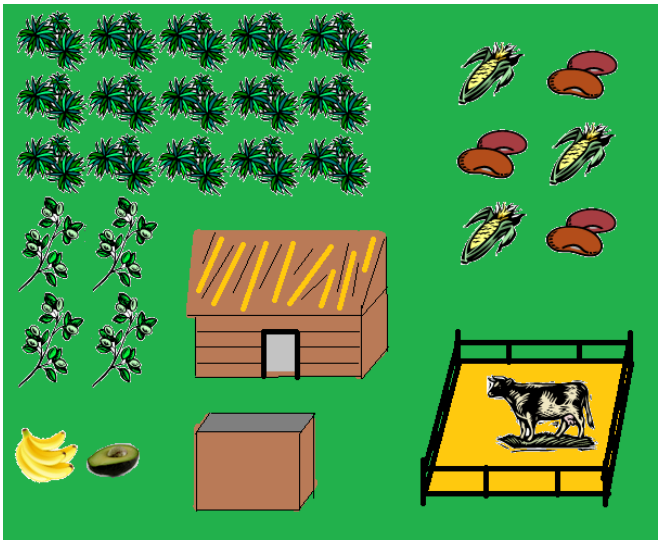


Figure 8. Typical farm in Kibugu, Embu District

4.1.1 General information

The average size of the respondents' farms is 1.5 acres and almost all of the land is used for cultivation. The reason for this is that land gets inherited by the sons in the family, and thereby the farmland each family receives decreases with every new generation. As a result farmers express that their plots are now too small to enable sustainable farming practices, such as to leave fields in fallow.

The age of the respondents has a mean of 49 years. Almost everyone (96%) has attended school. The highest number of farmers working full time on the same farm is 7, with an average of 2.2 full time farmers. These are the adults in the household that do not have another off-farm employment. The farms have on average 4.3 persons in the household to provide for.

Table 2. General information about the farmers and farms in Embu

Size of farm	1,5 acres
Area used for crop cultivation	1,2 acres
Average age	49 years
Average years of schooling	10,19 years
Average number of household members	4,3 persons

All the farms in the study have mixed production with livestock and crops. The main cash crops are coffee, tea and macadamia nuts. Maize and beans are the most common food crops, and are mainly grown for home consumption. However if an excess amount is received this might also be sold in

the market. Most farmers are members of a small cooperative where the coffee and tea is bought by local factories. The food crops are sold to neighbours or on the local market.

Table 3. Percentage of farmers cultivating a specified crop

Coffee	100%
Maize	100%
Tea	68%
Beans	56%
Macademia	36%

The average household has two cattle and six poultry, which are the most commonly held livestock, 88% have cattle and 72% poultry. A few farmers receive a small income by selling cow milk and chicks, but most is of these products are saved for home consumption.

The monthly household income varies between 250 KSH and 42 200 KSH. The mean income is 14 100 KSH per month and median income 8200 KSH. The distribution of the farmers' different incomes is shown in a box plot in figure 9 below. The box plot shows highest and lowest value and the 50 percent of values allocated in the middle.

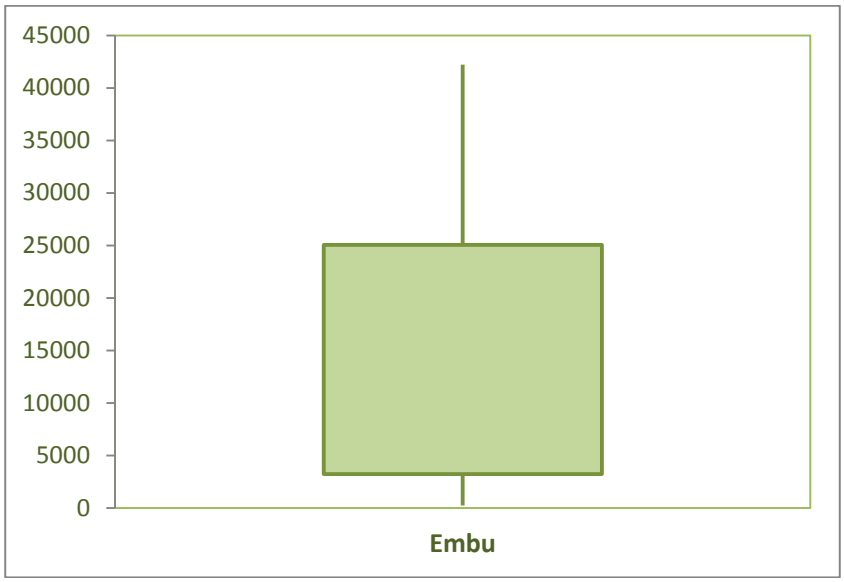


Figure 9, Allocation of incomes per month (KSH) in Embu shown in a box plot

4.1.2 Soil fertility management

The most commonly used practices to increase soil fertility are chemical fertilizer, intercropping and animal manure. Organic materials such as leafs are commonly used for surface mulching. Most of the animal manure is composted before it is applied since it gives better results than when applied fresh, and most farmers incorporate the manure in the soil. A majority of the farms use a combination of animal manure and chemical fertilizers. Most farmers rely entirely on rain water but 20% irrigate their plots with water from a nearby river

Table 4. The use of soil fertility enhancing practices during the last growing season

Animal Manure (composted)	100% (92%)
Chemical Fertilizer	96%
Intercropping	96%
Incorporation of manure	92%
Combination of manure and fertilizer	84%
Mulching	68%

The practices that are stated as most important to increase soil fertility are (on a scale of 1-5);

- Receive training in soil fertility management issues (4.64)
- Compost animal manure before spreading it (4.48)
- Understanding cropping patterns when doing crop rotation (4.44).
- Incorporate animal manure (4.28) crop residues (3.96) into the soil
- Use materials from the hedges as a mulch (4.12)
- Combine animal manure and chemical fertilizers (4.08)

The methods that are used to the least extent for increasing soil fertility are; crop residues (used by 28%), agro-industrial by products (40%) and faecal sludge (0%). Very few farmers (4%) feel that they can easily mobilize neighbours and friends to help when extra labor would be needed, for example with applying animal manure. Twelve percent report that they collect crop residues from their neighbours. Twelve percent also feed their animals with agro-industrial by products when these are accessible.

The practices that are stated as least important to increase soil fertility are (on a scale of 1-5);

- using faecal sludge in any way (1.00)
- mobilize neighbours and friends to help out with applying animal manure (1.16)
- making arrangements with neighbours to exchange fodder for animal manure (1.52)
- travel more than 3 km to collect animal manure (1.56)
- to spread fresh animal manure on the soil surface (1.72)
- to spread manure only at plots close to where it is stored (1.76)

The techniques of using green manure and crop rotation to increase soil fertility are implemented by 64% and 76% respectively. No one (0%) stated that they use any other soil fertility enhancing practice except from the things that were asked about.

In most cases techniques that are stated as important by the farmers when improving soil fertility correlate with the techniques that are most frequently used. An example of this is to incorporate manure in to the soil and to compost manure. Some farmers had made a furrow from the stable to simplify the carrying to the compost, see figure 10 below.

Figure 10. A furrow for animal manure from stable to compost

Figure 11. Cowshed with crop residues on the ground

It is high rated to incorporate crop residues in the soil but is only used by a few farmers. Farmers apply the crop residues in the stalls instead, with the purpose to absorb urine or to feed the animals as seen in figure 11. Because of the farms small sizes the grazing area is insufficient and therefore crop residues is required as fodder. It is difficult for the farmers to ask neighbours and friends to provide extra labor at the farm, even though some farmers state that this would be needed. This is because no one can spare labor for free, so it is more common that extra help is hired when needed.

Sometimes manure that has not been composted enough long time is applied when there is too little composted manure.

4.1.3 Willingness to pay

The average amount the farmers are willing to pay for one kilogram of the hybrid seed is 98 KSH. This amount differs between 30 and 170 KSH/kg. The most common answer is 100 KSH/kg (60%) and 76 % of the values are between 75 and 130. The distribution of different answers can be seen in figure 12 below. It shows the number of farmers stating a certain WTP. Note that the market price of this seed was approximately 180 KSH/kg for the time of the study (spring 2012).

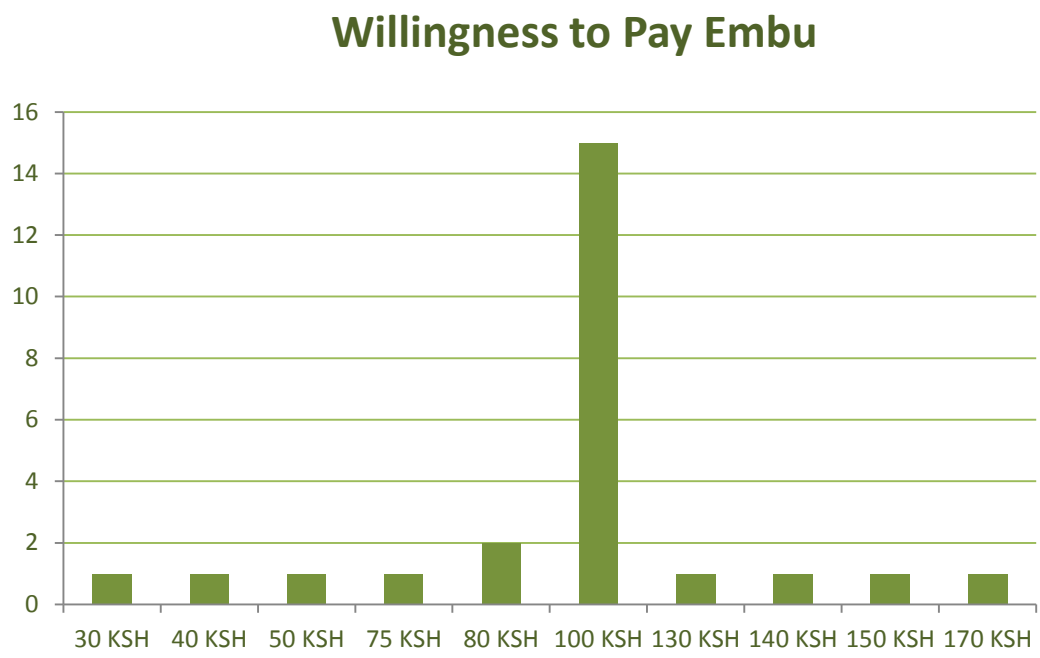


Figure 12. Distribution of willingness to pay in Embu

Among those who buy improved seeds today the average amount bought is 2.9 kg of the hybrid seed to the price of 193 KSH per kilogram. The farmers estimate that they need on average 3.9 kg of seeds to have a sufficient amount for their farm.

4.2 Bondo

A traditional homestead in Bondo often contains several houses, see figure 13. The number of buildings depends on the family's wealth. It is common with boundaries around the homestead area and livestock is grazing in the yard, often tethered up. There are rarely any stables for the animals. The farmland is located outside of the boundaries and is normally planted with maize, beans and different types of potatoes.

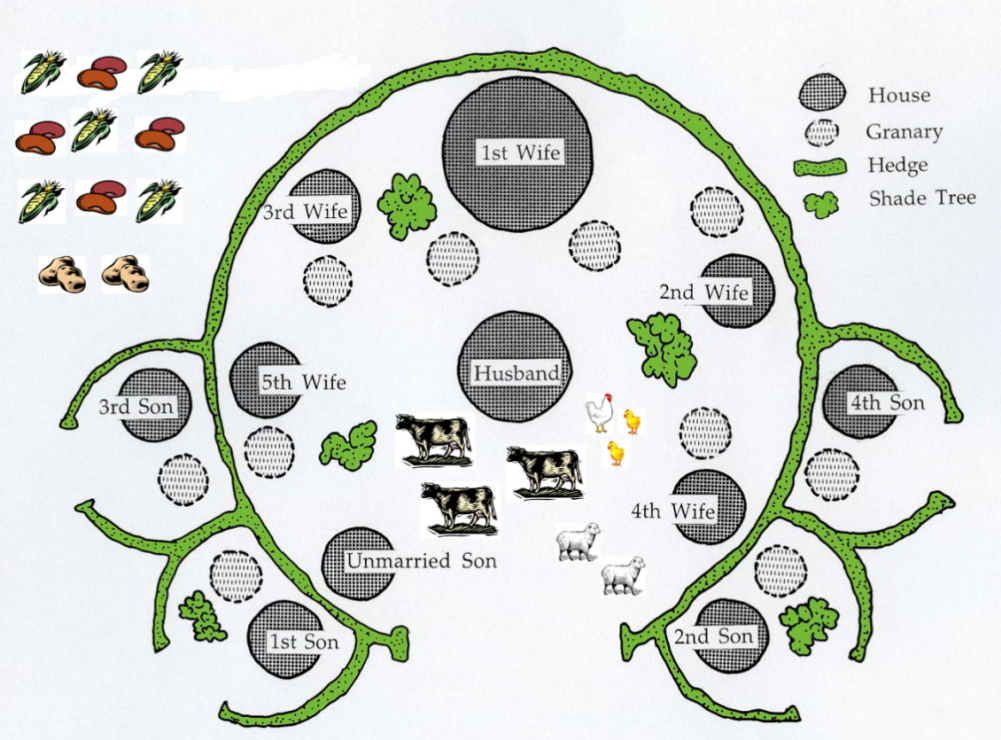


Figure 13. Traditional homestead in Bondo district

4.2.1 General information

The average farm in Bondo is relatively large, where one acre is reserved for the homestead area. The homestead area often serves as grazing land for the livestock on the farm.
The average amount of fulltime farm workers is 1.9 persons. A majority of the households has received education (68%), with a mean of 9.7 years. The highest educated household has attended school for totally 23 years, but 8 of the households have not received any education at all. The average household consists of a mean seven people, where the highest number is 31. Three households were single ones.

Table 5. General facts about the farms and farmers in Bondo

Size of farm	2,7 acres
Area used for crop cultivation	1,7 acres
Average age	49 years
Average years of schooling (per household)	9,7 years
Average number of household members	7 persons

Mixed farming with both livestock and crops is most common, which applies to all farms except two that had no or very few livestock. Maize and beans are the main food crops, other common crops are cassava, sorghum and potatoes. Only one fifth grow cash crops such as vegetables, timber, plants and groundnuts. Counting the farmers that also generate a small income from selling food crops when receiving an excess supply this share is fifty percent. The production is mainly sold on the local market in Bondo to other inhabitants with a low purchase power. This is quite a constraint

for the sellers, which could benefit if their products could be distributed into larger markets for example through a wholesaler.

Table 6. Percentage of farmers cultivating a specified crop

Maize	100 %
Beans	70 %
Cash crops (timber, plants, groundnuts)	20 %
Cassava	60 %
Sorghum	30 %
Potatoes	25 %

All farms except one have some type of livestock on their farm, and the typical farm has 2.5 cattle and 10.5 poultry. These animals are the most common and are held by 48% and 92% of the households. These are versatile livestock, since they also produce milk and eggs and are thereby preferable when lack of resources limits the amount of livestock that can be held. Goats (40%; 1.2 individuals) and sheep (40%; 1.2 individuals) is also common. Some farmers generate income from their livestock by selling for example chickens and puppies. Dogs are mainly used for pest control of monkeys, birds and rodents, and for protection.

Farmers stated that lack of inputs such as labor was a problem which makes it difficult to cultivate the whole farm. The average farm has barely two full time farm workers, if not including possible help from children in the household. Although only twenty-five percent state that they ever hire labor since few can afford it. Non-farm employments are uncommon which explains the low income levels that are described below.

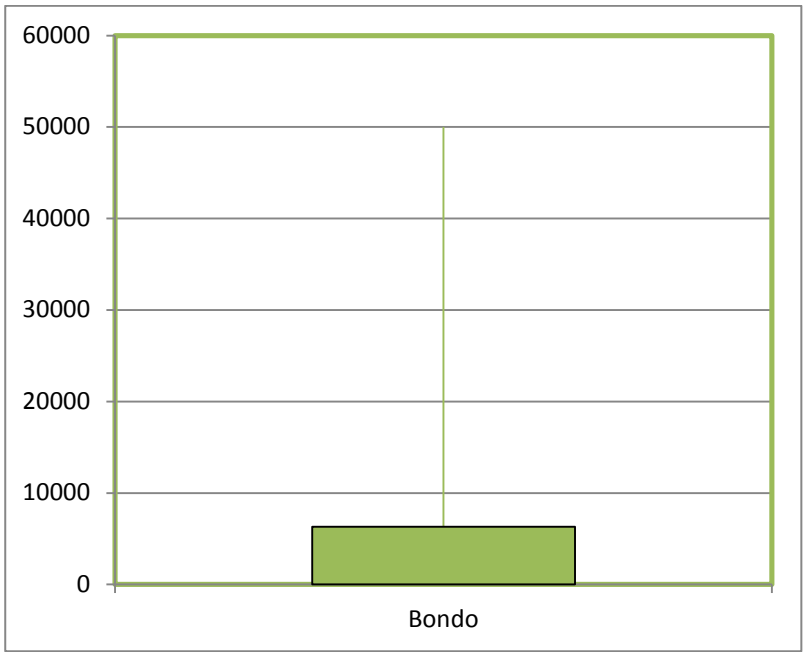


Figure 14, Allocation of incomes per month shown in a box plot

The average income in Bondo is 10 194 KSH/month and the median is 170 KSH. The highest income is 50000 KSH. One third has no income at all. Only one fourth earns 10 000 KSH/month or more, as shown in figure 14. The use of irrigation is rare, only 12% (3 out of 25) of the answers were positive. Education and income are unevenly distributed, and especially lack of income sources is causing problems. There used to be both a cotton factory and a sisal factory in the area which made it possible for farmers to grow these as cash crops. Unfortunately these industries closed down, leaving the farmers without this income possibility.

4.2.2 Soil fertility management

The most frequently used techniques are intercropping, animal manure and crop rotation. Livestock is often grazing, as seen in figure 15, and farmers thereby need less fodder. This enables an alternative use of organic materials such as crop residues. These can be used for mulching or manure. Although the free range makes it more difficult to collect since it is spread over a larger area, and the urine gets absorbed by the soil and can not be used. Intercropping with maize and beans is common, see table 7. Legumes that can fix nitrogen are an important source of nutrients since the use of organic and chemical fertilizer is limited. It does not require any extra labor since it is just a positive bi-effect.

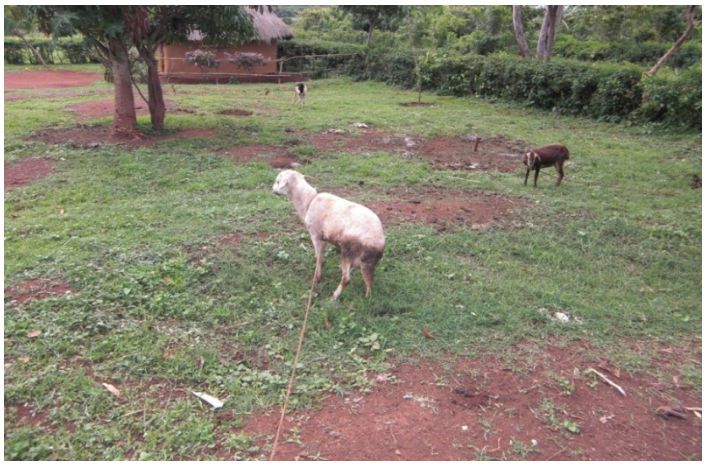


Figure 15. Grazing sheep in Bondo district

Crop residues are used as mulch and for incorporation in the soil. Animal manure is collected by 44% from no longer than 3 kilometres away. This is partly a cause of the grazing which can take place outside of the own land. Agro-industrial by-products and faecal sludge are completely unused. Chemical fertilizer is as well uncommon, around half had ever used it and only one third (32%) during the last season. Green manure is used by barely half (44%) of the respondents, and the same share had ever used the practice. Around one fourth (24%) has received training in soil fertility management.

Table 7. The use of soil fertility enhancing practices during the last growing season

Intercropping	92%
Animal Manure (composted)	80% (68%)
Incorporation of manure into soil	76%
Crop rotation	72%
Chemical Fertilizer	32%

The practices that are stated as most important to increase soil fertility are (on a scale of 1-5);

- Compost animal manure before spreading it (4.64)
- Receive training in soil fertility management issues (4.4)
- Incorporate animal manure (4.36) crop residues (4.36) into the soil
- Making use of crop residues as manure or for mulching (4.28)
- Receive training in using composted animal manure (3.8)

The practices that are stated as least important to increase soil fertility are (on a scale of 1-5);

- To combine animal manure and faecal wastes (1.8)
- Spreading fresh animal manure (1.88)
- to spread manure only at plots close to where it is stored (1.88)
- using faecal sludge (1.96)

There is also a couple of statements that got low numbers due to their irrelevancy, such as the ones concerning agro-industrial by-products, and collection and transport of manure and other materials from sources further than 3 kilometres away.

Most households have an insufficient income. They do not have any cash crops to sell or any non-farm sources of income. Even though some do have products to sell, it is difficult to find buyers when lack of money is a general problem. The use of production inputs such as chemical fertilizers and improved seeds is negatively affected by this. It explains in part the difference between the amount of seeds planted and the amount the farmers would like to buy for their farm if they had enough money.

4.2.3 Willingness to pay

The average price the respondents stated that they are willing to pay is 87 KSH per kilogram of the Open Pollinated Variety seed. The lowest amount is 20 KSH and the highest 250. A share of 70 percent of the answers is in the interval 49.5-100.5 KSH per kilogram. The distribution of the answers can be seen in figure 16. Note that the market price during the study was about 200 KSH/kg (Spring 2012).

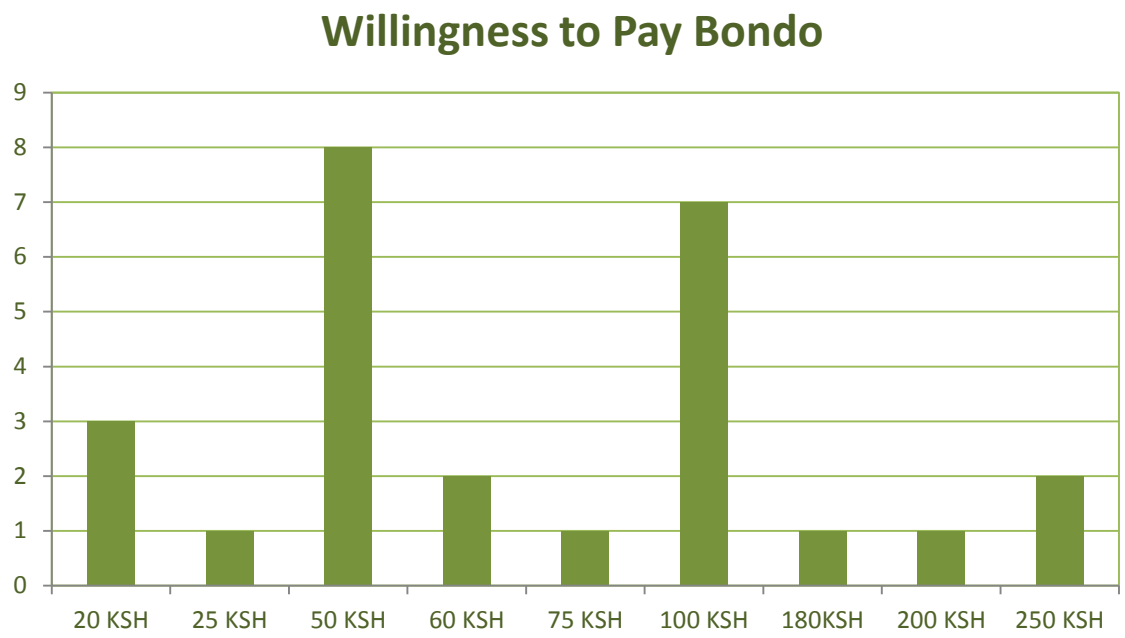


Figure 16, Distribution of willingness to pay in Bondo district

The average amount of seeds planted is 8.5 kilograms, where the highest amount is 20 kilos (three respondents) and the lowest is 2 kilos (one respondent). The farmers state that they would need a mean of 7 kilograms if they could use the more efficient improved seed. Generally the farmers would like to buy less seeds than they normally plant. Out of 21 answers, 10 would like to buy less, 10 would like to buy an equal amount and 1 would like to buy more. Of the farmers who buy seeds on a regular basis, 226 KSH/kg is the average price and 3 kg is the average amount (4 respondents).

5 Analysis and discussion

Here the specific objectives will be analyzed and answered, followed by a discussion.

5.1 WTP and the factor market

Most of the farmers don't use improved seeds at all and instead they rely on using an excessive amount of retained seeds. They have stated that the improved seeds need a lot of water to grow to their full potential and the risk of getting a bad yield in dry seasons is too high. Because of this they don't want to pay the high price of the improved seeds. The farmers who do use them have stated on average an amount that is considerably lower than the amount that they would actually need for their farm. This means that the farmers would like to buy more of the seeds if the price is right. The farmers stated average Willingness to pay for the seed was significantly lower than the current market price of the seeds. The farmers felt that the seeds were too costly compared to their budget and the perceived benefits of using the seed. These two circumstances imply that there exists a market failure connected to market power exercised by the supply side. If there are few suppliers they will be able to set a higher price then what is optimal in the competitive case in order to get higher profits and a lower quantity is bought.

5.2 Choice of inputs

A rational firm would not increase the level of one input without eventually increase other inputs to get an effective production. Therefore the use of and thereby the Willingness to pay for the input improved seeds should be positive correlated with the use of other inputs. A multiple linear regression with WTP as the dependent variable and the most important yield enhancing practises and income as the independent variables gave the result:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,541442
R Square	0,29316
Adjusted R Square	0,194531
Standard Error	45,77962
Observations	50

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	6	37376,25	6229,375	2,972352	0,016179
Residual	43	90118,25	2095,773		
Total	49	127494,5			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*
Intercept	44,42758	17,57193	2,528326	0,015213	8,990394
income	2,647893	1,791922	1,477683	0,14678	-0,96586
income^2	-0,03719	0,0431	-0,86276	0,393054	-0,1241
chemical fertilizers	19,63106	16,77245	1,170435	0,248272	-14,1938
animal manure	28,43013	18,22683	1,559795	0,126139	-8,32778
crop residues	35,0681	13,88321	2,525937	0,015303	7,06995
hire labor	-32,9873	15,5381	-2,123	0,03955	-64,3229

With 50 interviews and a probability of 95 % the t-stat of the coefficients needs to be higher than 1.676 to have a true positive sign which is the case for crop residues. With a probability of 90 % we can be certain that all inputs except using chemical fertilizers and hiring labor have a positive effect on the WTP of improved seeds (Körner, 1986). A number of regressions were made to find more significant results with high R^2 and higher t-stat of which a few can be found in appendix 6.

The impact of the different inputs on the WTP can be shown in the following estimated equation:

$$WTP = 44.43 + 2.65\,INC - 0.037\,INC^2 + 25.49\,FER + 25.45\,MAN + 35.08\,RES - 32.99\,LAB$$

where income is given in 1000 KSH and WTP in KSH/kg. Remember that the mean income in Embu is 14 100 KSH and in Bondo 8200 KSH. The coefficients for income give the slope of the line. Labor, fertilizers, manure and crop residues are dummies and these increase/lower the WTP with the corresponding coefficient by affecting the intercept.

According to the theory about output maximization and expansion path a rational firm increases their inputs in a cost effective way when they want to increase their output. When all inputs are variable they should be increased in a way that makes it possible to get the most output, in line with the law of the minimum. Using a lot of soil fertility enhancing methods does not give a lot of output, there needs to be a corresponding amount of seeds planted with it. Improved seeds will give even more output and is presumed to be preferred to retained seeds. Farmers who use a lot of inputs in their production should therefore have a higher WTP for improved seeds. The results of the regression show that using chemical fertilizers, animal manure and crop residues increase the Willingness to pay.

Hiring labor on the other hand has a negative effect on the WTP. This could be because there is a high price connected to it and the farmers has to choose between buying improved seeds or hiring labor. A small family might not have the labor capacity to weed or spread manure and therefore prioritize to hire labor.

5.3 Discussion

This section contains a discussion on reasons for market power and some suggestions on how they can be dealt with. Also a part on how farmers choose their inputs.

5.3.1 WTP and the factor market

There were many farmers that quickly stated the same willingness to pay value, which was 100 KSH/kg. It showed that this was in fact the price of hybrid seeds when it first was introduced in Embu. Farmers could buy at this price around 3 years ago and seems to think of it as a reasonable, affordable price. This price is significantly lower than the current market price. Most farmers have a small income and it is unlikely that it has been increasing with the same ratio as the price of improved seeds. It is therefore understandable that farmers perceive the price too high for them

The use of hybrid seeds was significantly more widespread in Embu than initially expected. A majority of respondents had knowledge about different types of hybrid seeds, and most had used them in their production. The OPV-seed was surprisingly unknown in both areas. This could be because the local market is very weighted towards hybrids. Both of the locations had very few resellers of improved seeds and the supply was often limited to one seed producer. Both of the areas in the study are remotely located. These rural farm areas are spread out and generally have a small and relatively poor population. Given this, the market is small, there are few customers and thereby the area has a low potential for businesses, which ultimately result in a small supply. Farmers lack of both financial and time resources so it is difficult for them to access other markets. Thereby most farmers are bound to the supply that is given in the area.

It is remarkable that the OPV seed is not being used, since it is a cheaper alternative to hybrid seeds. A use of hybrid seeds binds the farmers to purchase new for every season while OPV-seeds can be retained. However the companies in the industry are driven by profits and chose to promote and sell hybrids. Governmental institutions are not driven by the same economic incentives to promote products, such as the OPV-seed. This might be a reason to the OPV: s anonymity. These circumstances put the consumers in a situation where it is dependent on what is sold in the local market and make it possible for resellers to exercise market power because of the low or non existing competition. Since there are low incentives for new sellers to establish in the areas there is a need of government intervention to improve the situation. Resellers without competition have no incentives to lower their prices. To reach food security long-term the government could lower prices on the improved seeds that is developed at KARI and make sure that they reach the farmers. This will force the seed companies to lower their prices and the farmers will be able to purchase more and get a higher yield. The surplus could then be sold and generate income. This income can be used for further agricultural investments, eventually freeing labor from the agricultural sector and advance the industrialization of the economy.

To create this agricultural surplus the farmers could benefit from cooperation. One suggestion is that they buy OPV seeds together and plant them on a good piece of land and use all the necessary inputs such as fertilizers and irrigation to get a high yield. The yield should then be saved to be used as seeds the next season and divided by the farms that are involved in the project. Each farm has then a good amount of improved seeds to start with and can retain them for several seasons.

5.3.2 Choice of inputs

In both of the locations, although particularly in Bondo, farming is a lifestyle for subsistence purposes rather than a business. This reflects on to the production decisions which are not only based on economic rationality. It was discovered that farmers are influenced by factors such as tradition of using certain practices, familiarity with them, social acceptance, accessibility and time consumption. Since farmers also lacked of resources such as money and time, it was important to keep risks at a minimum by acting accordingly.

The farmers in the two areas differed in their way of farming. Embu farmers have a lot of knowledge about which soil fertility enhancing practices that are important. Further they give the impression of putting more thought into their production compared to Bondo farmers. A cause to this might be the fact that Embu is more affected by land scarcity and therefore need to utilize the land better through intensified production. The farmers in Bondo mainly grow for subsistence purposes, whereas in Embu most farmers grow some type of cash crop. This fact means that there are bigger possibilities for an extended and intensified production for the farmers in Bondo. If there were potential buyers of crops it would be an incentive to utilize the land better and increase production.

6 Conclusions

What is the Willingness to pay for improved seeds among smallholder farmers in central and western Kenya?
The Willingness to pay was 87 Kenya Shillings per kilogram in Bondo and 98 KSH/kg in Embu. This was in both cases significantly lower than the present market price. Many of the respondents stated that the price limited them from purchasing a sufficient amount of improved seeds. A lower price would thereby increase the consumption. There are few suppliers in the small rural villages, which enables the sellers to set a price above equilibrium. It is an existing market failure where the suppliers have market power. The government needs to interfere and increase competition by promoting seeds produced by governmental agencies and make sure that they reach the farmers. By also subsidizing the price the farmers can buy a sufficient amount of seeds which in the long run can improve food safety.

How do smallholder farmers in Kenya perceive different methods to improve soil fertility, and how does this affect the WTP?
It can be concluded that the use of some methods that the farmers saw as most important to improve soil fertility have a positive effect on the WTP for improved seeds. The input factors that affect the Willingness to pay positive are the use of chemical fertilizers, animal manure and crop residues. The income level is positively correlated with the stated WTP value while income squared has a negative correlation. In general the farmers have knowledge about how they could operate their farms in an efficient way. There are though several limitations in the production, such as lack of labor, time and money. There is a need of prioritizing when choosing which practices to use. Hiring labor is connected with high costs and that could be a reason why it has a negative effect on the WTP. The farmers are not completely rational in their production but are influenced by tradition, social acceptance and accessibility.

Bibliography

Literature and publications

Alphonce and Alfnes, 2012, *Consumer Willingness to Pay for Food Safety in Tanzania: An Incentive Aligned Conjoint Analysis*, International Journal of Consumer Studies, **Volume 36, Issue 4,** page 394–400

Ayieko, Miltone and Tschirley, David, 2006, *Enhancing Access and Utilization of Improved Seed for Food Security in Kenya*, Presentation available at http://aec.msu.edu/fs2/kenya/seed-presentation-final.pdf

Brännlund, R. Kriström, B. 1998*, Miljöekonomi,* Studentlitteratur AB, Lund, pp.100-116, ISBN: 9789144004747

Gravelle, H. Rees, R., 1992, *Microeconomics,* Longman Group UK Limited, 2nd edition, England, ISBN 0582023866

Hanson, H. Lagerkvist, C.J., 2011, *Measuring farmers' preferences for risk: a domain-specific preference scale,* Swedish University of Agricultural Sciences

Körner, Svante, 1986, *Tabeller och formler för statistiska beräkningar*, Studentlitteratur AB, Lund, (ISBN: 9789144014852

Lagerkvist, C,J. Hess, S. Ngigi, M. Okello, J. 2011, EAAE 2011 Congress, Consumers' Willingness to pay for Food Safety in Nairobi: The Case of Fresh Vegetables, Swedish University of Agricultural Sciences, Sweden, University of Nairobi, Kenya. Presentation available at http://ageconsearch.umn.edu/bitstream/114409/2/Lagerkvist_Carl_261.pdf

Ouma, J., F. Murithi, W. Mwangi, H. Verkuijl, M. Gethi, and H. De Groote. 2002, *Adoption of Maize Seed and Fertilizer Technologies in Embu District, Kenya*, Printed in Mexico for CIMMYT, available at http://apps.cimmyt.org/english/docs/tech_pubs/embu.pdf

Perloff, J.M. 2011, *Microeconomics with calculus,* Pearson Education Limited, England, 2nd edition, ISBN 978-1-4082-6432-4

Pindyck R.S. Rubinfeld, D.L. 2009, *Microeconomics,* Pearson Education Inc. New Jersey, USA, 7th edition, ISBN 978-0-13-713335-2

Seward, P. and Anderson, J.M., 2003, *FIPS Promotion of Improved Technology in Kenya through Small Seed- and Fertilizer-Packs*, PDF available at http://www.worldbank.org/html/extdr/fertilizeruse/documentspdf/FIPS_SmallPacks_Demos.pdf

Internet

CIA, Central Intelligence Agency, www.cia.gov

1. The world fact book, Kenya, 2012-06-06 https://www.cia.gov/library/publications/the-world-factbook/geos/ke.html
2. The world fact book, Sweden, 2012-06-06 https://www.cia.gov/library/publications/the-world-factbook/geos/sw.html

CIMMYT, International Maize and Wheat Improvement Center, www.cimmyt.org

1. Release of insect resistant maize hybrids, 2012-06-06 http://blog.cimmyt.org/?p=6087

Ecosystem valuation, www.ecosystemvaluation.org
1. Contingent Valuation, 2012-07-15
   http://www.ecosystemvaluation.org/contingent_valuation.htm

EU, Europeiska unionen, europa.eu
1. Jordbruk – Inte bara jordbruk, 2012-06-03
   http://europa.eu/pol/agr/index_sv.htm

FAO, Food and Agriculture Organization of the United Nation www.fao.org
1. White maize: a traditional food grain in developing countries, 2012-06-06
   http://www.fao.org/docrep/w2698e/w2698e03.htm
2. Willingness to Pay, 2012-05-24
   http://www.fao.org/DOCREP/003/X8955E/x8955e03.htm

Gaia Movement Trust, www.gaia-movement.org
1. What is an OPV, 2012-06-06
   http://www.gaia-movement.org/files/075_Open%20Pollinated%20Seeds.pdf

KARI, Kenya Agricultural Research Institute, www.kari.org
1. KSTP94: Striga tolerant Maize for Western Kenya, 2012-06-06
   http://www.kari.org/fileadmin/publications/brochuresII/KSTP94_Striga_tolerant_Maize.pdf

Kenya Seed Company, www.kenyaseed.com
1. Medium Altitude Maize Vareties, 2012-06-06
   http://www.kenyaseed.com/maize/medium-altitude-maize-varieties.html

Library of Congress, www.loc.gov
1. Country profile: Kenya, 2012-06-03
   http://lcweb2.loc.gov/frd/cs/profiles/Kenya.pdf

Primal Seeds, www.primalseeds.org
1. Hybrid vs Open Pollinated Seeds, 2012-06-03
   http://www.primalseeds.org/hybrid.htm

Sida, Styrelsen för internationellt utvecklingssamarbete, www.sida.se
1. Lär känna Kenya, 2012-06-06
   http://www.sida.se/Svenska/Lander--regioner/Afrika/Kenya/Lar-kanna-Kenya/
2. Afrikas jordbruk måste stärkas, 2012-06-06
   http://www.sida.se/Svenska/Kontakta-oss/For-medier/Debattartiklar/Arkiv-2009/Afrikas-jordbruk-maste-starkas/
3. Markinvesteringar bekämpar hunger, 2012-06-06
   http://www.sida.se/Svenska/Kontakta-oss/For-medier/Debattartiklar/Arkiv-2012/Debattartiklar-2012/Markinvesteringar-bekampar-hunger-/

UNICEF, www.unicef.org
1. Kenya at a glance, 2012-06-03
   http://www.unicef.org/kenya/overview_4616.html

Yr, www.yr.no
1. Været som var Kisumu, 2012-06-03
   http://www.yr.no/sted/Kenya/Nyanza/Kisumu/statistikk.html
2. Været som var Embu, 2012-06-03
   http://www.yr.no/sted/Kenya/%C3%98st-Kenya/Embu/statistikk.html

Personal messages

Keese, Paul. Doctor molecular biology
Email, 2012-06-06

Röing de Nowina, Kristina. Doctor, International Centre for Tropical Agriculture
Personal meeting, 2011-09-03

Figures

Figure 1, Wikipedia, www.wikipedia.org
1. Production function, 2013-11-18
http://en.wikipedia.org/wiki/File:Total,_Average,_and_Marginal_Product.gif

Figure 2, CAclubindia, www.caclubindia.com
2. Some Economics Theories, 2013-11-18
http://www.caclubindia.com/forum/-some-economics-theories--57597.asp#.Uoz-yMRWnvw

Figure 3, Wikipedia, www.wikipedia.org
3. Expansion path, 2013-11-18
http://en.wikipedia.org/wiki/File:Expansion-path.jpg

Figure 4-16, authors creation

Appendix 1 Questionnaire

Value and perception - Of improved seeds in relation to livelihood among small-holder farming systems in Kenya

The purpose with this study is to estimate willingness to pay for improved seeds. A risk-benefit analysis of the use of improved seeds will as well be a part of the study.

AGENDA

Before interview

- **Presentation of**: - Our names, origin and reason for visit

  - Our connection to the Swedish Agricultural University

  - The study and the purpose with the interview, a part of Sida, result in our Bachelor thesis, evaluate possibilities of increase in food production

- **Request to farmers**: - Their participation in the interview

  - If photographing is accepted - If we can be shown around the farm before the interview, and make a sketch of it.

- **Inform participants:** - We will come back to present our results for the participants after concluding our interviews the end of the study.

Interview

- **Part 1:** Basic facts about the farm and the person answering the questionnaire
- **Part 2:** A statement part – here the respondent will relay to 34 statements. First by answering them with Yes/No and then by ranking them from 1 to 5 according to their importance.
- **Part 3:** The Risk-Benefit analysis. The respondent will here indicate how important certain seeds or failure in using seeds are for increasing crop yield.

Intersession with refreshments

- **Part 4:** A payment-card where the willingness to pay for improved seeds is measured. The respondent has to state how much he or she is willing to pay for one kilogram of seeds.

Required equipment: Four questionnaires (where three of them are reusable), pens, markers, sodas, SLU-pens, folders, paper-clips, 1 kg of seeds

PART 1

1.1 FARMER AND SITE IDENTIFICATION

1.1.1 Respondent's name (in full).....

1.1.2 Location …… Sub-location ……

1.1.3 Village…… Phone number……..

1.1.4 Household Status…….. 1= Male headed, 0= Female Headed

1.1.5 Distance to the nearest local market (Km) ……

1.1.6 Distance to an agricultural extension office (Km) ……...

1.1.7 Distance to main road (km)……

1.2 FARMER'S SOCIAL AND DEMOGRAPHIC FACTORS

1.2.1 Household Membership list of members:

Please complete the table below for all the people who live in your household

Name of household member (start with respondent)	Gender (Codes A)	Ages (Years)	Marital status (Codes B)	Years of schooling	Main occupation (Codes C)
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					

9.					
10.					

Codes A **Codes B** **Codes C**

1. Male
2. Female

1. Married
2. Single
3. Widow/widower
4. Divorced
5. Separated

1. Full-time farmer
2. Full-time employee
3. Part-time employee
4. Self-employed
5. Student
6. Other *(specfy)*……

1.2.2 What type of farming do you undertake? ……List the major crops grown

……..

1.2.3 For how many years have you been doing farming? ……

1.2.4 What percentage of your production is sold? ……...%

1.2.5 What is the size of your farm in acres? .....

1.2.6 What size of your farm is under production? …… acres

1.2.9 Who is the **main** buyer of your production?

1.Local trader 4. Rural assemblers/brokers 7. Urban traders

2. Supermarket 5. Restaurants 8. Exporter

3. City markets 6. Neighbors 9. Others *(specify)*……..

1.2.10 Do you irrigate your plots? 1. Yes 0. No

1.2.11 If YES, what is your **main** source of irrigation water?

1. River / stream 4. Piped/ tap water 7. Sewage

2. Borehole (*kisima*) 5. Dam 8. Run-off water

3. Well (*kidimbwi*) 6. Roof water 9. Other (*specify*)……

1.3 Income sources (*Record from last season September 2011 – January 2012)*

Source of income		**Amount (Ksh)**
Farm income	Crop income	
	Livestock income	
Off-farm income	Farm *(e.g kibarua)*	
	Non-farm	
Other *(specify, e g pension, remittances)*		

1.4. Livestock production activities

1.4.1 Do you keep any livestock on your farm? 1. Yes 0. No

1.4.2 If YES, what type of livestock do you keep on your farm? *(Please do not report livestock that does not belong to this household).*

Livestock type:	**Number:**
1. Cattle	
2. Goats	
3. Sheep	
4. Donkeys	
5. Pigs	
6. Rabbits	
7. Poultry	

1.5 Membership to associations/groups

1. Do you belong to **any** farmer group? (*Codes A)*	**2.** Does **any** of the groups you belong to deal with vegetables / flowers*(Codes A)*	**3.** If YES in **2**, what is the **main** function of the group? (*Codes B*)	**4**. How long have you been a member?

Codes A

1. Yes

0. No

Codes B

1. Produce marketing
2. Crop production
3. Farmer research group
4. Providing labour for ploughing / weeding/ harvesting
5. Soil and water conservation
6. Input access
7. Savings and credit
8. Others *(Specify)*……

PART 2

2.1 SUSTAINABLE SOIL FERTILITY MANAGEMENT PRACTICES

2.1.1 Please indicate which of the following soil fertility enhancing practices you use or have ever used on your farm

Management practice	Ever Used?**1. Yes 0. No**	Used last season? **1. Yes 0. No**
1. Crop residues		
2. Green manure [e.g. Desmodium, Lantana*(mushomoro)*, Mucuna, Tithonia (*maroro)*, etc]		
3. Intercropping		
4. Cereal – legume intercropping		
5. Crop rotation		
6. Animal manure		
7. Compost manure		
8. Chemical fertilizer		
9. Agro-industrial by-products (e.g coffee husks, etc)		
10. Faecal sludge		
10. Other …….		

2.2 Please indicate whether you agree or disagree with the following statements *(tick appropriately)***.**

Statement	Yes	No
1. I have received training (including demonstrations, informal training) away from my farm site on soil fertility management.		
2. I identify and incorporate in the soil crop residues that are high in nutrients and easy to decompose.		
3. I collect crop residues from my neighbors after harvesting which I add to those I produce from my farm so that I can have enough to use		
4. I sometimes apply crop residues as a mulch		
5. I prune my hedges / boundaries and use the materials for surface mulching.		
6. I incorporate into the soil the materials I get after pruning the hedges and boundary crops.		
7. I collect animal manure from neighboring (max ½ kilometer) farmers in order to obtain sufficient amounts of manure for my [ ] production.		
8. I have to travel for several kilometers (more than 3 km) to get livestock manure.		
9. I make arrangements with my neighbors who keep livestock to supply me with animal manure in exchange for fodder.		
10. I apply straws/crop residues / wood shavings to the livestock stall for insulation and to absorb urine which I later apply on the field		
11. I have dug a furrow through which the livestock urine and dung from the shed flows directly to the farm where I have planted crops		
12. I have to hire a donkey cart from my neighbor in order to transport livestock manure from the source (more than 3 km) to my farm		
13. I hire enough labour to assist in the application of livestock manure		
14. I easily mobilize my neighbors and friends to help me in applying livestock manure to my crops		
15. I spread fresh livestock manure on the surface of the soil		
16. Based on the knowledge I have, I compost livestock manure before spreading to the soil surface		
17. I incorporate livestock manure into the soil		
18. I apply chemical fertilizers in micro-doses (match-box) volume equivalent at the root zone of the crops.		
19. I combine chemical fertilizers with organic manure		
20. I practice crop rotation / intercropping because it fits in my cropping patterns.		
21. I always include legumes in the crop rotations / intercropping		

22. I often apply agro-industrial by-products (coffee husks) from nearby agro-processing factories on my farm to supplement livestock manure and chemical fertilizer		
23. I feed agro-industrial by-products I get from agro-processors to livestock so that I can get quality livestock manure, which I then apply to my soils		
24. I often hire a truck / donkey cart to transport agro-industrial by-products (coffee husks) from agro-processing factories which are far (more than 5 km) away from my farm so that I can apply on my farm.		
25. I seek / have sought training from agricultural extension officers on how to prepare and apply compost manure.		
26. In absence of livestock manure, I make use of human faecal sludge for my production.		
27. I use human faecal wastes on my farm from my own family.		
28. I source for human faecal wastes from my neighbors.		
29. I apply livestock manure, or faecal sludge only at plots close to the place where I store it		
30. I combine human faecal sludge with livestock /compost manure		
31. I have enough family labour to enable the application of compost & farmyard manure.		
32. I hire labour to enable the application of compost / farmyard manure		
33. I always use deep-rooting green manure crops in my crop rotation in order to recover nutrients from lower soil horizons		
34.I have lined the floor of the livestock stall with concrete to allow regular collection of urine which I apply on the farm		

3. **Please use the following scale for the next set of statements to indicate the extent to which the following statements describe yourself** *(tick appropriately)*

1	Strongly disagree
2	Disagree
3	Neither disagree nor agree
4	Agree
5	Strongly agree

Statement	**1**	**2**	**3**	**4**	**5**
1. It is important for me to have received training on soil fertility management provided by agricultural extension services.					
2. Identifying and incorporating in the soil crop residues that are high in nutrients and					

easy to decompose will improve soil fertility status.					
3. It is necessary to collect crop residues from my neighbors after harvesting to add to those I produce from my farm so that I will have enough to apply on my farm.					
4. It is important for me to apply crop residues as a mulch					
5. For my farming it is important to prune my hedges / boundaries and use the materials for surface mulching.					
6. Incorporating into the soil the materials I get after pruning the hedges and boundary crops will increase soil fertility.					
7. For me it is important to collect livestock manure from neighboring (max ½ kilometer) farmers in order to obtain appropriate amounts of manure for my [ ] production.					
8. I travel for several kilometers (more than 3 km) to get livestock manure.					
9. Making arrangements with my neighbors who keep livestock to supply me with livestock manure in exchange for fodder is important.					
10. It is important to apply straws and wood shavings to the livestock stall for insulation and to absorb urine to be applied in the field.					
11. It is important for me to line the floor of the livestock stall with concrete to allow regular collection of urine to be applied on the farm.					
12. It is necessary to dig a furrow through which the livestock urine and dung from the shed flows directly to the farm where I have planted crops					
13. It is important for me to hire a donkey cart from my neighbor in order to transport livestock manure from the source (more than 3 km) to my farm					
14. It is necessary to hire enough labour to assist in the application of livestock manure					
15. Mobilizing my neighbors and friends to help me in applying livestock manure to my crops is important for me.					
16. It is important to first compost livestock manure before spreading to the soil surface					
17. Applying chemical fertilizers in micro-doses (match-box) volume equivalent at the root zone of the crops is important.					
18. It is important to combine chemical fertilizers with organic manure					
19. It is important to spread fresh livestock manure on the surface of the soil					
20. Understanding cropping patterns on my farm is important for crop rotation					
21. It is important to incorporate livestock manure into the soil					

22. It is important to apply agro-industrial by-products (coffee husks) from nearby agro-processing factories on my farm to supplement livestock manure and chemical fertilizer					
23. Feeding agro-industrial by-products from agro-processors to livestock is important in order to get quality livestock manure to apply to my soils					
24. It is of importance to me to hire a truck / donkey cart to transport agro-industrial by-products (coffee husks, rice husks) from agro-processing factories which are far (more than 5Km) away from my farm so that I can apply on my farm.					
25. It is important to me to seek training from agricultural extension officers on how to prepare and apply compost manure.					
26. It is important to me to make use of human faecal sludge for my production.					
27. It is necessary to use human faecal wastes in my farming because I believe it would release nutrients easily for the crops I grow on my farm.					
28. I apply livestock manure, or faecal sludge only at plots close to the place where I store it					
29. In my farming it is necessary to combine human faecal sludge with livestock /compost manure					
30. It would be of importance for me to hire enough labour to enable the application of compost & farmyard manure.					
31. It is important to me to use deep-rooting green manures in my crop rotation because I believe that they recover nutrients from lower soil horizons					

PART 3. A measure of benefits and risks in general use of seeds

3.1 please use the following scale to indicate how important the following techniques are in increasing the crop yield at your farm

Very important	5
Important	4
Neither important nor unimportant	3
Less important	2
Not important at all	1
Cannot say, because I do not use this technique	0

Statement - Improved seeds	**0**	**1**	**2**	**3**	**4**	**5**
Use of hybrid seeds alone						
Use of open pollinated variety (OPV) seeds alone						
Use of own produced seeds alone						
Combined own produced seeds and hybrid seeds						
Combined own produced seeds and OPV seeds						
Combined hybrid seeds and OPV seeds						
Leaving the farm fallow for sometime						
Use of weed resistant seeds						
Use of fungus resistant seeds						
Use of insect resistant seeds						

3.2 Please use the following scale to indicate how you think lack of use of the following techniques would lead to lower crop yield at your farm

To a very large extent	5
To a large extent	4
I don't know	3
To a less extent	2
To a very less extent	1
Cannot say, because I do not use this technique	0

Statement - improved seeds	**0**	**1**	**2**	**3**	**4**	**5**
Not using hybrid seeds alone						
Not using OPV seeds alone						
Not using own produced seeds alone						
Not combining hybrid and own produced seeds						
Not combining OPV and own produced seeds						
Not combining hybrid and OPV seeds						
Not leaving the farm fallow for sometime						
Not using weed resistant seeds						
Not using fungus resistant seeds						
Not using insect resistant seeds						

Sketch of farm:

Appendix 2 Payment Card Embu

Part: 4 Willingness-to-pay for improved seeds

Scenario 1: Own produced seeds
These seeds are fertile and can be used again as retained seeds. When collecting seed from your own plants, you get the seeds for free, but it may take a little time to prepare them. The seeds that you can collect from your own crops are not reistant to weeds or diseases. A common problem in Embu is the Stemborer larvae. It feeds on leafs and can starve the plant of nutrients. This means that you risk losing some parts of the crop yield and the harvest might not be big enough to sell some of the maize or to feed your family. The seeds that you have collected from your own production are adapted to the local climate and altitude, and needs normal quantity of water and fertilizer. The harvest of the own produced seed is unstable due to possible pest problems. Normally it yields 3-5 bags/acre (90 kg/bag). Young stem borer larvae feed on leafs which can lead to potential destruction of the growing point while older larvae burrow into the stem, where they starve the growing plant of nutrients.

Below: Stem borer damaged maize. The top has died.

Scenario 2: Hybrid seed
A hybrid seed is developed to fit a particular environment. It is sterile, which means that you have to buy new seeds every season. It has a high yield potential, but requires perfect conditions to reach it, including much water, (pesticides) and fertilizer. These factors create high production costs, but will probably result in a high harvest and generate more income. A healthier and stronger maize plant produces better looking cobs, which is more attractive to the consumer and might give the farmer a higher selling price. This particular hybrid is developed for the short rain period, which means that it has a short growing period. For medium altitude maize growing (1000-1800 meters above sea level) it is high yielding, resistant to leaf diseases and pests. It grows to a height of just over 3 meters above soil level. It matures fairly early 4-6 months after planting and yields about 20 bags of grain per acre (90 kg/bag).

Insect resistant maize. Healthy leafs.

Estimation of willingness-to-pay

On this sheet are written different amounts of money from nothing up to more than X shillings. Starting at the top of the list and moving down please ask yourself: 'Am I willing to pay 10 shilling extra per kilo of seed to buy the second type seed just described? Or would I rather not pay this amount and have the first seed described? If you are almost certain you would pay the amounts of money in the card to buy the second seeds then place a tick (√) in the space next to these amounts.

Scenario 1: Retained seeds from own plants	**Scenario 2: Hybrid seed**
• No purchase cost • Local variation adapted to the surroundings • Matures after 3-5 months • It is often from low-producing plants, about 3-5 90 kg-bags per acre • It is vulnerable to weeds and diseases, needs pesticides or manual control • Fertile and can be used again as retained seed • No extra costs for watering and fertilizers, needs only rainwater and animal manure from own livestock	• Developed for the short rain period • It matures fairly early, 4-6 months after planting • Suited for medium altitude, 1000-1800 meters above sea level • High yielding, and yields about 20 bags of grain per acre (90 kg/bag) • Resistant to leaf diseases and some pests • Sterile and can only be used for one period • Needs a lot of water and fertilizers to reach full potential
Indicate by ticking in the appropriate box how much you are willing to pay for product scenario 2.	0 shilling/kilogram 1-10 shilling/kilogram 11-20 Shilling/kilogram 21-30 Shilling/kilogram 31-40 Shilling/kilogram 41-50 Shilling/kilogram 51-60 Shilling/kilogram 61-70 Shilling/kilogram 71-80 Shilling/kilogram 81-90 Shilling/kilogram 91-100 Shilling/kilogram 101-110 Shilling/kilogram 111-120 Shilling/kilogram 121-130 Shilling/kilogram 131-140 Shilling/kilogram 141-150 Shilling/kilogram 151-160 Shilling/kilogram 161-170 Shilling/kilogram 171-180 Shilling/kilogram 181-190 Shilling/kilogram 191-200 Shilling/kilogram More than 200 Shilling/kilogram

Please don't agree to pay an amount if you think you can't <u>afford it on a regular basis</u> or if you feel that there are more important things for you to spend your money on, or if you are not sure about being prepared to pay or not.

We are asking for your most truly willingness-to-pay here so please provide the sincere response.

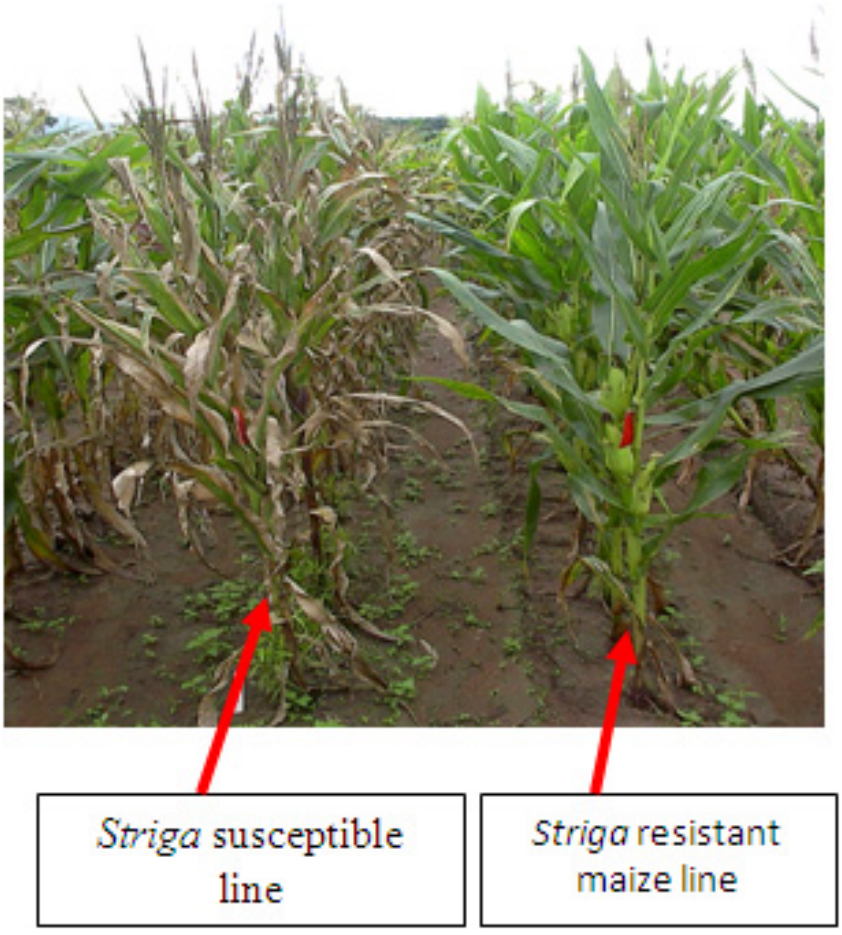
Thank you very much for your time!

Appendix 3 Payment Card Bondo

Part: 4 Willingness-to-pay for improved seeds

Scenario 1: Non-striga resistant maize seed
When collecting seed from your own plants, you get the seeds for free, but it may take a little time to prepare them. Own produced seeds is not modified or treated with pesticides. This mean that the own seed is not as high producing or resistant to weed, diseases or other problems as a hybrid or OPV seed.
A common weed in Kisumu is striga, which most farmers have in their maize fields. It is a parasite that sticks on to the roots of the maize plant. It survives by taking nutrients from the crop, leaving it starving. The maize gets weakened and if the striga is not removed, the maize plant can die. You can remove it by hand or buy herbicides which is expensive. It is common that striga destroys one third up to entire fields of crop. This means that the harvest might not be big enough to sell some of the maize or to feed your family.
This seed is adapted to the local climate and altitude, and needs normal quantity of water and fertilizer.
The harvest of the own produced seed is more insecure then the seed in scenario 2.

Scenario 2: Striga resistant OPV maize seed
In scenario 2, you buy the seed. It is resistant to striga weed, so the likeliness of striga problems is much lower. You will put less time in removing striga from your field, or money into buying herbicides. This open pollinated variation (OPV) maize seed is recommended in Kisumu. It is fertile so it is possible to select seeds from previous crop as seed for next season. It is only allowed to use the same seeds for 3 growing periods, after that you have to buy new seeds from the same source. This seed is appropriate in both the long and the short rain period, and yields around 17-22 90-kilo bags/acre.
The harvest of this seed is more secure, since the risk of striga infestation is much lower. It requires more water and fertilizer to reach its full yield potential then the seed in scenario 1. But it has a higher yield even without more water and fertilizer.



Estimation of willingness-to-pay

On this sheet are written different amounts of money from nothing up to more than X shillings. Starting at the top of the list and moving down please ask yourself: 'Am I willing to pay 10 shilling extra per kilo of seed to buy the second type seed just described? Or would I rather not pay this amount and have the first seed described? If you are almost certain you would pay the amounts of money in the card to buy the second seeds then place a tick (√) in the space next to these amounts.

Scenario 1: Own produced seed	**Scenario 2: OPV seed**
• No purchase cost • Not striga resistant, can lead to large yield losses • Often low-producing, yields around 3-5 bags/acre Low stability in size of crop-yield which can lead to low income	• Re-purchases needed every third season • Yieldpotential17-22 bags/acre (1 bag = 90 kg) • Low risk of striga problems • Requires much fertilizer and water to reach full yield potential, but has a relatively high yield even without
Indicate by ticking in the appropriate box how much <u>more</u> you are willing to pay <u>extra</u> for product scenario 2 as compared to product scenario 1	0 shilling/kilogram
	1-10 shilling/kilogram
	11-20 Shilling/kilogram
	21-30 Shilling/kilogram
	31-40 Shilling/kilogram
	41-50 Shilling/kilogram
	51-60 Shilling/kilogram
	61-70 Shilling/kilogram
	71-80 Shilling/kilogram
	81-90 Shilling/kilogram
	91-100 Shilling/kilogram
	101-110 Shilling/kilogram
	111-120 Shilling/kilogram
	121-130 Shilling/kilogram
	131-140 Shilling/kilogram
	141-150 Shilling/kilogram
	151-160 Shilling/kilogram
	161-170 Shilling/kilogram
	171-180 Shilling/kilogram
	181-190 Shilling/kilogram
	191-200 Shilling/kilogram
	More than 200 Shilling/kilogram
	0 shilling/kilogram

Please don't agree to pay an amount if you think you can't <u>afford it on a regular basis</u> or if you feel that there are more important things for you to spend your money on, or if you are not sure about being prepared to pay or not.

We are asking for your most truly willingness-to-pay here so please provide the sincere response. **Thank you very much for your time!**

Appendix 4 Feedback Embu

Reflections on interviews in Kibugu (Embu)

First, we would like to thank you very much for your participation in our study. It has been very helpful and educational for us! In this feedback to you we will make some comparisons between the two areas in Kisumu and Embu, and try to give you some advises.

The farms are generally bigger in Bondo then in Kibugu. In both places the farmers think that leaving the plots to rest is very important in increasing crop yield. But due to lack of land it is difficult to implement in Kibugu. It is more commonly used in Bondo. Most of the livestock in Bondo is walking freely and grazing in the nature. The farmers do not have to feed their animals with crop residues, and can use them to increase soil fertility instead. The farmers in Kibugu think that crop residues would be good for the soil, but they have to use them as animal feeds. Animal manure and crop residues are limited resources, and most farmers would like to get access to more if they could.

The most commonly used practices to increase soil fertility were chemical fertilizer, intercropping and composted animal manure. More than half use materials from the hedges for surface mulching and applies crop residues on the stall floors to simplify the collection of animal manure. Almost everyone compost their animal manure because it will work better then when applied fresh. It is also very common to incorporate animal manure in the soil and combine animal manure with chemical fertilizers. The things the Kibugu farmers think is most important to increase soil fertility is;

- to receive training on soil fertility and on how to prepare and apply animal manure
- incorporate crop residues and animal manure in the soil
- use materials from the hedges as a mulch
- compost animal manure before spreading it
- combine animal manure and chemical fertilizers
- to understand cropping patterns when doing crop rotation.

The use of seeds is much differentiated in the two areas. Everyone in Kibugu uses hybrid seeds, while the local seeds are as good as gone. It is the opposite situation in Bondo, where a majority of the farmers still uses the local seeds. The farmers in Kibugu grow coffee and tea as cash crops, and thereby have an income which makes it possible for them to buy seeds. The OPV seed was unknown to the farmers in both Kibugu and Bondo, though the interest of trying it is big after hearing about it from us. The willingness to pay for the seed is between 30-170 KSH/kg, with an average of 98 KSH/kg.

We hope this information will be helpful and interesting for you. Thank you once again for your help!

Best wishes,

Henrik & Anna

Appendix 5 Feedback Bondo

Reflections on interviews in Bondo (Kisumu)

First, we would like to thank you very much for your participation in our study. It has been very helpful and educational for us! In this feedback to you we will make some comparisons between the two areas in Kisumu and Embu, and try to give you some advises.

The farms are generally bigger in Bondo then in Kibugu. In both places the farmers thinks that leaving the plots to rest is very important in increasing crop yield. But due to lack of land it is difficult to implement in Kibugu. It is more commonly used in Bondo. Most of the livestock in Bondo is walking freely and grazing in the nature. The farmers do not have to feed their animals with crop residues, and can use them to increase soil fertility instead. The farmers in Kibugu think that crop residues would be good for the soil, but they have to use them as animal feeds instead.
Animal manure and crop residues are limited resources, and most farmers would like to get access to more if they could. Though the materials they get from pruning hedges and boundaries remains unused. They are normally burned, even though it could probably help to bring nutrients to the soil. It would be good to use these leafs instead of buying chemical fertilizers that is expensive and might not work well if there is a shortage of rain.

The use of seeds is much differentiated in the two areas. Everyone in Kibugu uses hybrid seeds, while the local seeds are as good as extinct. It is the opposite situation in Bondo, where a majority of the farmers still uses the local seeds. The farmers in Kibugu grow coffee and tea as cash crops, and thereby have an income which enables them to purchase seeds. The OPV seed was unknown to the farmers in both Kibugu and Bondo, though the interest of trying it is big after hearing about it from us. The willingness to pay for the seed is between 20-250 KSH/kg, with an average of 87 KSH/kg.

We hope this information will be helpful and interesting for you. Thank you once again for your help!

Best wishes,

Henrik & Anna

Appendix 6 Opt out regressions

WTP dependent on several inputs

Regression Statistics	
Multiple R	0,583876
R Square	0,340911
Adjusted R Square	0,171914
Standard Error	46,41789
Observations	50

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	10	43464,28	4346,428	2,017259	0,057902
Residual	39	84030,22	2154,621		
Total	49	127494,5			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	46,05774	18,87097	2,440666	0,019304
income	0,001191	0,000627	1,900553	0,06477
cropland	0,372768	7,412602	0,050288	0,960149
trained	-11,2587	16,26043	-0,6924	0,492788
hire labor	-21,3551	16,40557	-1,3017	0,200656
irrigation	29,11404	19,9805	1,457122	0,153088
chemical fertilizers	16,74455	17,18184	0,974549	0,33579
com. animal manure	18,44888	19,23239	0,959261	0,343337
crop residues	28,40038	16,45877	1,725547	0,092346
mulch	2,820519	15,55752	0,181296	0,857074
crop rotation	13,44279	14,8228	0,906899	0,37003

Ln WTP dependent on ln income

Regression Statistics	
Multiple R	0,571499
R Square	0,326611
Adjusted R Square	0,250089
Standard Error	0,51311
Observations	50

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	5,618718	1,123744	4,268219	0,002991
Residual	44	11,58439	0,263282		
Total	49	17,20311			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	3,547229	0,238643	14,86415	9,16E-19
ln income	0,037922	0,025883	1,46509	0,150006
hire labor	-0,28564	0,169176	-1,68844	0,098403
chemical fertilizers	0,354198	0,184566	1,919082	0,061475
com. animal manure	0,418468	0,200888	2,083091	0,043086
crop residues	0,478645	0,154444	3,099142	0,003378